"NATURE", SEPTEMBER 29, 1956

SUPPLEMENTS: RECENT SCIENTIFIC AND TECHNICAL BOOKS
INDEX TO VOLUME 177

DESK
UNIVERSITY OF MICHIGAN
OCT 15 1956
PERIODICAL READING ROOM

VOL. 178, No. 4535 SATURDAY, SEPTEMBER 29, 1956 THREE SHILLINGS

C. Baker
OF HOLBORN LTD. EST 1765

APLANATIC MAGNIFIERS

×6, ×8,

×10, ×15, ×20

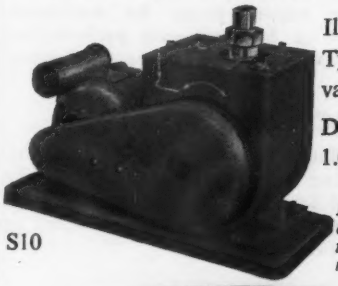
Cemented triplet lenses yielding well corrected images and flat fields of view. In handy single or double pocket mounts.

Particulars on request:

C. BAKER OF HOLBORN LTD., METRON WORKS PURLEY WAY, CROYDON, SURREY (CROydon 3845-6-7)

Showrooms: 244 High Holborn, London, W.C.1

METROVAC
ROTARY VACUUM PUMPS



Illustrated is the Type S10 rotary vacuum pump.

Displacement: 1.0 litres/sec.

S10

Please write for details of other models in our range.

METROPOLITAN-VICKERS

Member of the A.E.I. group of Companies

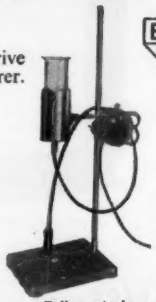
OVER THIRTY YEARS EXPERIENCE IN THE HIGH VACUUM FIELD

N/P403

LABORATORY STIRRERS

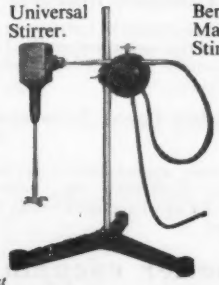
Combined Hot Plate Magnetic Stirrer.

Direct Drive & Flexible Drive Magnetic Stirrer.



BTL

Universal Stirrer.



Bench Type Magnetic Stirrer.

Full particulars on request

BAIRD & TATLOCK (LONDON) LTD.

Scientific Instrument Makers

CHADWELL HEATH, ESSEX, ENGLAND

Filter Interference Plant

THE model 19VE5, the latest addition to the EDWARDS range of coating equipment, has been specially developed to fully exploit the technique of depositing *accurately controlled* single or multi-layers of thin films.

OUTSTANDING FEATURES

EVAPORATION

Turret source for sequential evaporation of up to six materials.

PUMPING SYSTEM

Air-ballasted rotary pump and self-fractionating vapour pump for maximum efficiency of high vacuum performance even in the presence of contaminating vapours.

FILM THICKNESS CONTROL

A modulated light source photometer, for controlling film thickness, is correctly designed for integral operation with the plant. It is unaffected by ambient or vapour source light.

SOME APPLICATIONS

Anti-reflecting and Double Layer Coatings

Interference coatings for the suppression of reflection from the surfaces of glass and other dielectrics.

High-reflecting Coatings

The deposition on glass of a non-absorbing film of *sufficient* optical thickness to produce high-reflecting deposits.

Multi-layer Interference Filters (Dichroic mirrors)

Based on alternate deposition of interference films of high and low refractive index materials. Filters of this kind are invaluable in the fields of colour television and spectroscopy.

'All-Dielectric' Fabry-Perot Interference Filters

Invaluable for many applications at present using expensive optical equipment, e.g., prism monochromators, etc., for providing light within a narrow transmission band.

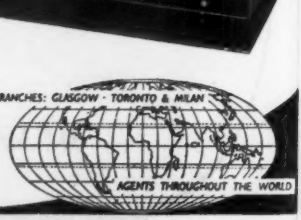
Accurately Controlled

THIN FILMS AND ADVANCED DEPOSITION EQUIPMENT

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY



NATURE

No. 4535 SATURDAY, SEPTEMBER 29, 1956 Vol. 178

CONTENTS

	Page
Future of the British Association	657
Pavlov and his Concepts. By Dr. W. H. Thorpe, F.R.S.	659
Automatic Control and Machines. By Dr. John C. West	661
Electronics in Physics and Engineering. By S. Weintroub	661
Scientific Background of Tanning. By Dr. D. E. Hathway	662
The British Association for the Advancement of Science. By Ritchie Calder, C.B.E.	664
United States Programme for the International Geophysical Year. By Dr. Joseph Kaplan	665
Progress of Cancer Research	667
Science by the Upper Form. By Dr. F. J. North, O.B.E.	670
Obituaries:	
Dr. G. J. H. Swoboda. By Sir Graham Sutton, C.B.E., F.R.S.	671
Dr. C. B. Rees. By Prof. A. C. Hardy, F.R.S.	672
News and Views	672
Microscopy with X-Rays: Symposium in Cambridge. By Dr. V. E. Cosslett	676
The Eighteenth International Geographical Congress. By Prof. L. Dudley Stamp, C.B.E.	677
Science and Strategy. By Prof. E. C. Baughan, O.B.E.	678
Research Council of Alberta: Report for 1955	679
Relativity and Space Travel. By Prof. Herbert Dingle; Prof. W. H. McCrea, F.R.S.	680
The Stoichiometric Relationship between Amino-Acid and Nucleotide Residues in a Ribonucleoprotein. By Prof. Erwin Chargaff, Dr. David Elson and Dr. Harold T. Shigeura	682
Mechanism of Entry of 5-Bromouracil and Orthophosphate into Deoxyribonucleic Acid of *E. coli*. By Drs. T. D. Price, P. B. Hudson, H. H. Hinds, R. A. Darmstadt and S. Zamenhof	684
Letters to the Editors:	
Rotation Period of the Planet Venus as determined by Radio Observations.—Prof. John D. Kraus	687
The Second Purple Light.—E. L. Deacon	688
Physical Constants in Extra-Galactic Nebulæ.—Prof. M. P. Savedoff	688
Suggested Experiment on the Relativistic Contraction of Time.—R. Herman	689
A Determination of the Line-width of the λ6300 Line of Oxygen in the Twilight Sky.—David Q. Wark	689
The Maximum of a Distribution- or Spectrum-Function.—Dr. W. van der Bijl	691
Phase-distribution in and near the Bright Nucleus of an Aberration-free Diffraction Image.—E. H. Linfoot and Dr. E. Wolf	691
A Very Rapid Two-Stage Solid–Solid Reaction and the Mosaic Structure of Potassium Permanganate.—R. A. W. Hill and A. A. Wallace	692
Mass-Spectrometric Detection of the Ion $(SrOK)^+$.—Dr. T. M. Sugden, P. F. Knewstubb and K. F. Smith	693
Isolation of the Stable Boron Trifluoride – Hydrogen Fluoride Complexes of the Methylbenzenes; the Onium Salt (or σ-Complex) Structure of the Friedel-Crafts Complexes.—Dr. G. Oláh, S. Kuhn and A. Pavláth	693
Notation for Serum-Protein Groups and the Genes controlling their Inheritance.—Dr. O. Smithies and Dr. Norma Ford Walker	694
Hæmoglobin *E* in Malaya.—Dr. H. Lehmann and R. Bhagwan Singh	695
Oxidation *in vitro* of Radioactive Œstradiol by Preparations of Human Tissue.—Dr. Robert M. Dowben and Joseph L. Rabinowitz	696
Pseudo-cholinesterase in Rat Erythrocytes.—D. R. Davies and J. P. Rutland	697
Receptor Occupancy and Tissue Response.—Prof. Mark Nickerson	697
Ammonia Production in the Collecting Ducts of Mammalian Kidneys.—R. Richterich-van Baerle, Leon Goldstein and Dr. Earl H. Dearborn	698
Catalase Production by Lactobacilli.—Dr. J. C. Dacre and Dr. M. Elisabeth Sharpe	700
Staining Properties of the Golgi Zone of the Shell Gland of the Dogfish.—Dr. L. T. Threadgold	700
A Toxic Lipid from the Surface of *Corynebacterium ovis*.—Prof. H. R. Carne, Nancy Wickham and Joan C. Kater	701
Occurrence of New *Salmonella* Types from South Africa.—Dr. J. Deom	702
Influence of Nutritional State on the Heat Tolerance of Cattle.—N. T. M. Yeates	702
Identification of *Pseudomonas pyocyanea* by the Oxidase Reaction.—Nicholas Kovacs	703
Structure of the Ascidian *Octacnemus* Moseley.—R. H. Millar	703
Hand-rearing of Rabbits.—Doris M. Hills and Dr. I. Macdonald	704
Insecticide Resistance in *Anopheles gambiae* Giles.—G. Davidson	705
A High Frequency of Heterozygous Diploids and Somatic Recombination produced by Ultra-violet Light in Imperfect Fungi.—Chiyoko Ishitani	706
"Polyploidy in Bluebells."—Dr. W. B. Turrill	706
Recent Scientific and Technical Books	Supp. viii

INFORMATION ?

with pleasure . . .

Among Kodak services to industrial and scientific photographers is the provision of free literature on practically every aspect of applied photography. Recent publications include :

BOOKLETS

'Photography at Work', 'Can Industrial Radiography Help You?', 'Recording Materials'.

LEAFLETS

'Document Copying Papers', 'The Scope of Gamma-radiography', 'Light Filters', 'A Furnace-scanning Periscope'.

DATA SHEETS

'The Dimensional Stability of Photographic Film', 'Stains on Negatives and Prints', 'Exposure in Colour Photography'.

Kodak LIMITED Kodak House, Kingsway, London, W.C.2 *'Kodak' is a registered trade-mark*

DIRECT READING pH METER

MODEL 23A

This high-grade laboratory pH Meter is one of the most widely used instruments in electrochemical research.

Some 50 different types of electrodes are available for pH, Redox and micro analytical work. Stable to 0.02 pH with a B.S. precision meter and a recorder output.

E·I·L the pH people

ELECTRONIC INSTRUMENTS LIMITED · RICHMOND . SURREY . ENGLAND

RIChmond 5656

E7

FUTURE OF THE BRITISH ASSOCIATION

WHILE it is true that of recent years there has been a growing amount of criticism of the British Association, much of that criticism has come from within the Association itself. As such it reflects the effort of the Association to adjust itself and its functions to serve more effectively the needs of the present time. Moreover, as Mr. Ritchie Calder observes in an article on the Association (see p. 664 of this issue), since the Association, more than any other scientific body, brings the whole range of science within its scope and at the same time provides a forum for discussion with the public, its proceedings have in consequence inevitably mirrored the complexities of modern science and the confusion of the lay attitudes to science.

Mr. Calder's article, however, is concerned mainly to set forth the new conception of the functions of the Association which has emerged from the work of the influential committee under the chairmanship of Sir Ben Lockspeiser appointed by the Council early this year to consider the functions of the British Association in the present-day world and to explain the way in which the Association works. The annual meeting of the Association is unique among scientific meetings in Great Britain both in range and in size, and the Lockspeiser Committee was concerned in the first place with re-defining the function of these meetings. There is likely to be little dissent from the three broad objectives which the Council in consequence set forth in a statement issued at the Sheffield meeting. There is manifestly need for a platform in which leading scientists can discuss their work in all its theoretical complexities so that the public may understand the integrity and discipline involved in the search for scientific knowledge for its own sake and, even if only incidentally, something of the conditions in which alone creative work is fruitful or even possible. No less apparent is the opportunity which the very structure of the Association affords of checking the excesses of specialization and the fragmentation of science, which have separated scientists working in different fields and made them almost unintelligible to each other, by bringing them together in joint sessions so that they can share experience in related fields and recognize problems on the frontiers of present knowledge. Lastly, and in keeping with its consistent and unique tradition, the British Association must meet the needs of non-specialists, whether they be scientists outside their own field or interested laymen.

It is not suggested that this is the order of relative importance of these three objectives, but all three are objectives which probably no other body is in so good a position to serve as the British Association, provided it enjoys the full support of scientists themselves and has at its disposal the necessary resources. The real problems arise in the field of technique, particularly of organization and of communication. The latter, as Mr. Calder notes, may well involve much fuller use of the instruments of mass-communication and the acceptance by scientists of some guidance by the Press and by broadcasting and television experts as to the most effective method of popular presentation of scientific material. The former, as the statement of the Council indicates, involves some measure of conscious planning of the Association's meetings.

The Council is clearly aware of some of the difficulties and of the value and importance of consultation with the Press, radio and television authorities. For the Association to discharge such functions to-day much more is involved than changes in the education of the scientist himself which will both widen his outlook and enable him to interpret his work more effectively to fellow scientists working in other fields and to the interested layman. The conflict of time-tables and interests, for example, which, as Mr. Calder points out, at present hinders full use being made of the opportunities of widening interests already to be found in the Association's annual meeting, will not be removed without the full understanding and co-operation of the several sections and their officers. The Programme Co-ordinating Committee which the Council has now to set up to supplement the work of the Section Committees is unlikely to succeed in ensuring a balanced programme for an annual meeting as a whole unless the purpose of such co-ordination is widely understood and appreciated in the sections.

There will be the more confidence that such planning by consent will be effective in that so much of the constructive criticism has come from within. It may be recalled that three years ago, at the Liverpool meeting, Dr. W. E. Swinton in his presidential address to the Assembly of Corresponding Societies subjected the functions of the Association and the Assembly and its constituent societies to a critical re-examination in the light of the environment and the climate of opinion in which they are set to-day (see *Nature*, **172**, 782; 1953). At Sheffield, while Sir Raymond Priestley in his presidential address referred to the serious study now being made by the Association as to how best it could discharge its responsibilities in the circumstances of to-day, and asserted that its functions of integration and dissemination were more important than ever, Dr. F. J. North in his presidential address to the Assembly of Corresponding Societies reviewed critically the place of the local society in the community of to-day.

This particular address was indeed the subject of a subsequent discussion and should be noted for its bearing on what Mr. Calder suggests is an even more important aspect of the proposals for increasing the influence and effectiveness of the Association. The local societies are continuing bodies which to be effective must meet at regular and frequent intervals if they are to maintain close touch with the community. The British Association meets only once a year, and the Council is conscious that other forms of service are required to give continuity to its

efforts. It suggests that there is a place for a suitably planned and presented non-specialist scientific journal, and since it is imperative that scientists and laymen should be seen to accept the need to foresee and debate the social and political consequences of science, it suggests also that prominent industrialists and political leaders and others should be invited to contribute to sessions not only at the annual meeting but also at special one-day meetings on specific subjects.

Such suggestions are not in fact new. The British Science Guild was formed more than a generation ago for much the same purpose, and since 1938 the Division of Social and International Relations of the Association, which at the discretion of the Council can meet anywhere, at any time, on any appropriate subject, has provided the means for such meetings of the Association during the year. Financial difficulties and the lack of adequate staff have severely restricted the meetings of the Division, however, since the War. A powerful new Committee has now been appointed, and it is proposed that during the year the Division should meet industrialists, farmers, administrators, trade unions, women's organizations and any other sections of the community whose interests are affected by science.

While in this way the Association may well establish contact with new sources of membership, this development should not be considered in isolation from the other proposals affecting the annual meeting. For one thing, the majority of members, in the future, as in the past, are likely to be scientists, and the solution of the problem of making the Association more effective depends at least in part in making the Association more attractive to scientists themselves and in particular in drawing to its meetings more of those age-groups and occupations which at present are largely absent. It is generally agreed that at the Sheffield meeting there was a larger proportion of those aged under thirty than in recent years. The bulk of the members attending the annual meetings are either under thirty or in the older age groups. The middle-age groups, which provide most of the active research workers and leaders of research teams, are usually absent, and the industrial scientist, if persuaded to present a paper or participate in a discussion, usually arrives just in time for his session and hurries away directly it is over. Often enough he has not even paused to consider whether or not the programme offers him a noteworthy opportunity to learn about or discuss advances or trends in some discipline other than that in which he is immediately concerned.

One of the first tasks of the new co-ordinating committee is, by tactful persuasion and consultation, to influence decisions on the main topics to be discussed at the annual meetings, at least to the extent of reducing the number of trivial and disconnected papers and increasing the number of more fruitful meetings at which specialists in different branches of science and laymen with varied interests can discuss questions requiring illumination from different directions. For this purpose the Association must be in close touch with scientific opinion in general.

As has been observed, the British Association is a unique institution, and its traditions hold much of value which should still help to determine its functions. Moreover, the character of professional and scientific institutions generally is changing and in the past generation fairly rapidly. Against the proliferation of small societies must be set the growing size of the major bodies which increasingly robs them of the intimate and social character they once possessed.

Whether or not the mounting costs of publication will set limits to the proliferation of societies it is unlikely that the growth of the major institutions will be halted. They are likely to be increasingly used by the Government and other bodies for consultation in professional and technical matters and to provide the most convenient and appropriate channels for co-operation with like institutions abroad or for international action in professional or technical matters within their competence. Frequently they may come to be looked upon by their members rather as qualifying and publishing bodies than as societies requiring service from their members.

Such tendencies may well make the new role forecast for the British Association even more important and at the same time widen the opportunities for it to summon scientists to this twin duty of integration and dissemination. While the Association itself is at the moment primarily concerned with improving the mechanics of the Association, it is unlikely that there will be any halt in the efforts which in recent years have been made, within and without the Association, to raise the general standard of scientific exposition and to devise improved methods of general education both for the scientist and for the non-scientist. The Association may well with profit discuss such matters again in the future. For the moment it must concentrate on making its meetings as attractive as possible to the widest range of scientists and laymen, having regard to the limits which are inevitably set by any one place of meeting, and to ensure that the organization and timing of the meetings really permit those attending them to take the full advantage of them at least in relation to the three specific objectives of the whole annual meeting.

If this is to be done it means that the Association must attract to its meetings not merely more of the younger scientists and lively minds of the young generation but also a continuing reasonable proportion of leading scientists and technologists who count it worth while to interpret their work and thought to such an audience and to discuss with other specialists its social and political as well as its scientific or technological implications. A higher proportion of the middle-age groups of scientists and technologists is also desirable. Clearly this means good publicity as well as a carefully planned and well-arranged programme of specific and major topics. It involves also adequate finance. As Sir Raymond Priestley observed: "We have to make our meetings so attractive that our membership taxes the accommodation of the great cities in which we meet. At the same time, we must convince

industry that we have a task worth doing and are equal to that task".

The Council's statement shows clearly that the British Association is fully alive to its changed responsibilities and new opportunities in the world of to-day. Given the support of scientists generally which the new proposals fully deserve, the Association may well make an even greater contribution to the life of the nation than it has done in the past, provided only the handicap of inadequate financial resources is removed. If, however, the support of industrial or other benefactors is to be attracted on a large scale the programme of the Association must contain the large specific projects which manifestly compel the attendance and support of leading industrialists, scientists and administrators themselves and justify an industrial firm or other organization sending its young people to attend the meetings. Its educational functions could well justify support from Government sources; but the support from industry and commerce alone which an appropriate programme could attract would be much more worth while and in itself might remove the difficulty which since the War has handicapped so severely the Association and especially its Division of Social and International Relations.

PAVLOV AND HIS CONCEPTS

Selected Works

By I. P. Pavlov. (Edited under the supervision of Kh. S. Koshtoyants.) Pp. 654. (Moscow: Foreign Languages Publishing House; London: Central Books, Ltd., 1955.) 10*s.* 6*d.*

IT is fifteen years since any of Pavlov's major writings were issued in an English translation, so the publication of an English edition of a selection of his works is something of an event. The book jacket claims this to be "the most representative selection of Pavlov's works yet published in English". In one sense only, namely that it includes publications on all the subjects on which Pavlov worked and from every period of his life, is this true. It is unfortunate, however, that the book gives no clue to the fact that rather more than two-thirds consists of a selection of lectures and addresses already published in English long ago. This section of the book therefore needs no comment. Among those which appear here for the first time in English are three papers on "The Accommodation Mechanism of the Blood Vessels" (1877), on "Digestion" (1899), on "The Trophic Action of the Nervous System" (1920) and a minor article dated 1936 on "Voluntary Movements". There is also a paper (1938) on "The Theory of Types", two on "The Problem of Sleep" of the same date and two on "The Experimental Pathology of the Higher Nervous System". These last two cover much the same ground as a paper read in the same year to the Second International Congress of Neurologists in London and published in 1941 in New York as Chapter 56 of Prof. Gantt's translation of Pavlov's writings on "Conditioned Reflexes and Psychiatry". New material also includes a collection of ten public speeches and addresses, mostly quite trivial, and a three-page autobiography almost completely lacking in interest. The translation is reasonably adequate. The production is unattractive; but the price is very low. There is no index.

There are two other parts of the book which are both new and interesting: an introductory essay by Prof. Kh. S. Koshtoyants on "Pavlov and the Significance of his Works"; and the concluding section, consisting of about seventy pages of translations of stenographic records of selected statements made at the 'Wednesday' gatherings. These 'research seminars' were held from 1921 until 1935, and minutes were apparently kept for the last six years. Three volumes of these records were issued in the U.S.S.R. in 1949; but the fragments here given constitute the only translations so far published. It is thus to the first and last sections of the book that we must look for new material and for a clue as to the *raison d'être* of the publication as a whole.

The introduction contains some material of historical interest and is of some value in relating the development of Pavlov's work and of his views to the general attitude of mind of Russian (and by no means only Russian) biological science at that time. The real danger to the scientific study of behaviour presented by the subjective psychology of that time is made clear and Pavlov's violent reaction to it intelligible, and in this introduction some of his true greatness emerges. But unfortunately much of the introduction is taken up by bombastic statements about Pavlov's influence and achievement. Thus (p. 22) "Sechenov's basic postulate that the organism cannot exist without its supporting external environment is experimentally proved and in a way rounded off by Pavlov's theory of conditioned reflexes". Pavlov is given lavish praise for his naïve ideas on the second signalling system (merely a crude physiological scheme to account for the symbolism of human speech). We are told that "they point before his followers new avenues of research in the sphere of the physiology of the higher nervous activity, the way indicated to future generations of physiologists by their great teacher". Finally, on pp. 36–37, we read that because of Pavlov "it proved possible for the first time in the history of science to apply the precise method of investigation of natural science to the highly complex phenomena of the so-called psychical activity in man and animals", and this is why "it encountered the animosity of a number of scientists and idealist philosophers, lackeys of the imperialistic bougeoisie"—among whom are apparently numbered Sherrington, Lashley, Wolfgang Köhler and Woodworth! This kind of pathetic claptrap has been only too familiar in Russian writing in recent years, and there is, of course, the very real excuse for it that it was no doubt produced under a sense of extreme political threat. If, as we hope, the Russian sense of humour is now being freed from some at least of its chains, we may be sure that such writing will soon be treated with the same contempt and derision inside the U.S.S.R. that it has always received outside.

The final section (12), the "Records of the Wednesday Gatherings", is the most interesting part of the book. These fragments have apparently been chosen to show Pavlov's unswerving enmity to anything considered to be non-Marxist in science. This is a sad disservice to the memory of Pavlov, since it merely shows his worst side and makes him appear a petulant, intolerant and narrow-minded pedant. In fact, we know from his biographers that, although often appearing an irritable martinet,

underneath he was a jovial, lovable enthusiast who, whatever his defects and whatever anyone else did, was enjoying himself hugely throughout his long life and was (to quote Rebecca West) "feeding his investigatory reflex like a king and filling it full of the good factual cheer it wanted".

The confusion of thought exhibited in some of the charges against men such as Sherrington, Köhler and Lashley is indeed a sad commentary on the limitations of a very great man and makes weary reading. But to students of the psychology of genius and still more of the philosophy of science they are extremely instructive. Wolfgang Köhler's "Mentality of Apes" and Sherrington's Rede Lecture "The Brain and its Mechanisms" come in for particularly severe criticism. Let us take the attack on Sherrington as perhaps the most fundamental and illuminating. The Sherrington booklet certainly has some obscure sentences, but Pavlov seems out for deliberate and blatant misrepresentation; and I believe that all this confusion is due to Pavlov's own gradually growing mental muddle over the meaning of the term 'reflex' and that it has an important lesson for present-day students of scientific method. The original idea of the reflex was simply an observed, consistent correlation between stimulus and response; using the last two words in a simple physiological sense. Obviously when receptor and effector are distinct and in different parts of the body, some form of conduction mechanism has to be postulated. Sherrington, like so many neurophysiologists before and since, was concerned with relating the characteristics of reflex response to a supposed elementary nervous conduction mechanism—the reflex arc—and it is upon the inclusion, within the reflex concept, of the idea of some such simple conduction mechanism that its usefulness as a physiological term really depends. Regarding the synapse as a physico-chemical system, Sherrington was, of course, trying to see how far the various characteristics of the reflex—summation, facilitation, latency, refractory phase, after-discharge, inhibition, post-inhibitory rebound—could help in accounting for the behaviour of the animal when a large number of such reflex arcs became integrated to form units of the higher nervous system.

To say that Pavlov was not a neuro-physiologist in the strict sense at all is in no way to belittle his great achievement. Strangely enough, he was, in his behavioural work, a psychologist, since he was concerned with investigating the laws governing relations between stimulus and response but not really interested in the possible mechanism intercalated between them as expressions of the known properties of neurones, the characteristics of conduction and of the synapse. Thus, as Konorski[1] (who has done more than anyone to relate the work of the two) has pointed out, his theory was essentially an anti-neurone theory. Nevertheless, all the time he undoubtedly had the idea at the back of his mind that, since a reflex arc is a physiological mechanism, the use of the term reflex itself made his work physiological and thereby gave it greater scientific reliability. So he was wont to attack not only the old introspective psychologists, some of whom no doubt deserved it, but all physiologists who saw that the known reflex-arc mechanism was inadequate as the sole basis of animal and human behaviour. He was quite unable to see that, as von Holst[2] says, there may be many mechanisms with other modes of function within the nervous system. "We merely recognize fragments of some of them and call them reflex; but this term denotes fragments of very different mechanisms." Yet Pavlov continually widened his own use of the term reflex (see his writings, of almost unbelievable naïvety, on "the freedom reflex", the "reflex of life", and the "reflex of purpose") until gradually it came merely to mean 'response' and then finally meant practically nothing at all! He also spoke of "purposive acting science", of the dog having "the idea of food", and used other similar phrases in reference both to human and animal behaviour. He even spoke of an animal "aspiring to the attainment of a definite exciting object" ("Lectures", 1, Ch. 27, p. 276). Yet he repeatedly refused to allow that there was anything in behaviour except stimulation from the exterior. But, as Agar[3] has shown, he really planned his experiments, as we all do, simply by trying to set up situations which he hoped would yield fruitful results; and in devising such situations, he was constantly guided not by considerations of what may happen in the cortex but by the knowledge of human mental processes. "The tacit, and of course correct, assumption underlying the plan of the classical Pavlov experiment is that in order that the dog may learn that the sound of the whistle means that food is coming, experience of the sequence silence–no food, is as necessary as the sequence whistle–food. The reason for planning the experiment on this assumption can only be the recognition that we ourselves would have no ground to base an anticipation of food following the sound of a whistle unless we were able to compare the two experiences of silence followed by no food and sound by food."[3] So there is no reason for the oft-expressed statement that this method of biological investigation of behaviour possesses greater validity or is more physiological than any other method purporting to deal with memory, judgment, perception, etc. Both types of investigation must be carried out scientifically, and both must be judged by their results.

Marxists, of course, do not officially deny the effective existence of mind; but they do deny the dualism of mind and matter, and hence, calling themselves materialists, often come to speak as if mind is by definition something less important than matter. Pavlov was in effect, and of necessity, just as much a dualist as any of those he criticizes, probably more so than some of them. Over this he is ambiguous. At times ("Lectures", 2, Ch. 45) he appears to be a thorough-going mechanist, speaking as if he believes physiology can look forward eventually to absorbing psychology. Elsewhere ("Lectures", 2, Ch. 54) he denies being a mechanist and comes to admit, albeit rather confusedly, that he is a dualist. But Prof. Koshtoyants will not admit the fact. There is a highly significant mistranslation of Pavlov on this point in the book under review. In the 1941 standard edition of Vol. 2 of "Lectures on Conditioned Reflexes" ("Conditioned Reflexes and Psychiatry", Lawrence and Wishart, London) on p. 149 (also quoted in the introduction, p. 24) Pavlov says: "I wish here to emphasise the incoherence, the absurdity of a reconciliation between the subjective and the mechanical state. For me there is here a gross misunderstanding." This paper was published originally in French, and I have confirmed that this translation is correct. But Koshtoyants's edition, p. 546, makes Pavlov say: "they [his opponents] want to stress as strongly as they can the obvious inaptitude and absurdity of trying to link subjective

feelings and mechanics. In my view this is an obvious misunderstanding".

As a result of all this confusion, Pavlov burdened himself with a series of verbal subterfuges which are now seen to make nonsense. Worse still, he fastened these upon his followers in the form of a terminology which hindered a whole generation of them from going forward to tackle the really interesting problems which he had the insight to see were awaiting them. The modern development of elaborate cybernetic mechanisms as analogical tools for the study of the higher nervous centres is a very important one and likely to be of great service. Psychologists in recent decades have tended more and more to neglect the old concern with thoughts, feelings and sensations and to suspect introspection. There are good historical and other reasons for this. But consideration of brain models and of Pavlov's concepts brings one back again to the fundamental question whether, if one is concerned to understand behaviour, one is following the best course when one neglects altogether, to quote Tustin[4], the "one privileged access available to such immediate precedents and accompaniments of behaviour as thoughts and feelings, that are part of the complex of events of which behaviour is also a part". The usual way of escape is to fall back on the precious word 'complexity' and to assume that, because of its complexity, the brain is conscious and that a machine elaborate enough to maintain an inner representation of the outer world may thereby be conscious. But, as Tustin says, this is no explanation. For to regard consciousness as an emergent does not merely fail to explain consciousness in terms of assumed elementary physical mechanisms; it assumes that it is inexplicable on that basis. This is the kind of fundamental theoretical difficulty which was the basis of Pavlov's confusion, as it is of many to-day. As Whitehead says, science must be continually criticizing its own foundations if it is not to be in danger of developing into a medley of *ad hoc* hypotheses.

W. H. THORPE

[1] Konorski, J., "Conditioned Reflexes and Neuron Organisation" (Cambridge, 1948).
[3] Holst, E. von, *Brit. J. Anim. Behav.*, **2**, 89 (1954).
[3] Agar, W. E., "A Contribution to the Theory of Living Organism" (Oxford, 1943).
[4] Tustin, A., *Brit. J. Psychol.*, **44**, 24 (1953).

AUTOMATIC CONTROL AND MACHINES

Automation

Friend or Foe? By R. H. Macmillan. Pp. viii + 100 + 8 plates. (Cambridge: At the University Press, 1956.) 8*s*. 6*d*. net.

THIS small book of approximately twenty-four thousand words is based on the author's series of B.B.C. broadcasts, on automatic control and automatic production, in the Third Programme. In the introduction the meaning of the word automation is described as automatic production and the striving for a fully automatic factory. From the rest of the book it becomes obvious that the only new discovery in the past decade in this field is the word automation itself. The three branches of engineering science which must combine to make automation possible—namely, automatic control or servomechanism theory, mechanization of production, and electronic digital computers—are dealt with in four of the six chapters of the book. The remaining two are devoted to economics and future prospects.

The theory of control systems, which is the author's own field of research work, is introduced by a historical sketch of various automatic mechanisms from seventeenth-century pressure cookers to mid-twentieth-century naval gunnery. The development of the understanding of these various individual mechanisms into a fundamental science is brought out by discussing some of the famous theoretical personalities—Maxwell, Routh and Nyquist—who have contributed greatly to the theory of servomechanisms. The aim of this section is to bring out in non-technical language the concept of feedback. The essence of the section on production can be summed up in the two phrases 'line production' and 'transfer machines'. These are methods established in the 1920's. Automatic computers are dealt with in Chapter 5, again on a historical basis. Pascal (1642), Leibniz (1673) and Babbage (1829) are given as the early forerunners who laid down the basic principles of the modern high-speed electronic counterparts. Sufficient emphasis is not given to the major developments by ingenious inventions of large-capacity storage of data with, at the same time, rapid access to any required piece of stored information. Analogue computers are also mentioned and incorrectly termed 'simulators' (p. 63). The reader is also left with the erroneous view (p. 73) that, in general, the analogue computer is much faster than the digital machine.

The chapter on economics is weak; only the factors affecting the installation of equipment are considered. The overall economy, including the treatment of labour redundancy, is not dealt with. On reaching the last chapter, on "Present Impact and Future Prospects", one is disappointed to find that it does not deal with the book's provocative title but is devoted exclusively to the expansion of the feedback concept of the control engineer into other sciences such as physiology, biology, zoology, theory of economics, etc.

This is a very interesting and well-written book which does not demand any scientific knowledge of the reader. It is a great pity the contents are not covered by the title.

JOHN C. WEST

ELECTRONICS IN PHYSICS AND ENGINEERING

Advances in Electronics and Electron Physics

Edited by L. Marton. Vol. 7, 1955. Pp. x + 527. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 11.50 dollars.

THE seventh volume in this now well-established and excellent series of specialist review articles contains much the same blend of physical and engineering electronics as its predecessors; but there is a somewhat stronger emphasis on related solid-state phenomena. The contents consist of seven independent reports of advances in widely different branches, ranging from semiconductors to radio astronomy. The reports vary in length from forty to a hundred pages, and each includes a very extensive bibliography of well over a hundred references. The "Advances", like the many other similar annual reviews of individual branches of science, fulfil a very important function in these days when the volume

of published research is so extensive. Each article is a model of clarity and conciseness, containing a wealth of up-to-date information, and is compiled by authors who have obviously a first-hand knowledge of their subjects.

Two articles—the physics of semiconductor materials, by E. Burstein and P. H. Egli (Crystal Branch, United States Naval Research Laboratory), and theory of electrical properties of germanium and silicon, by H. Brooks (Harvard University)—summarize our present knowledge of the nature and structure of semiconductors, including the recent substantial progress that has been made in the determination of the energy-level structure of the valence-type semiconductors. E. Rudberg in the early 1930's clearly demonstrated that when slow electrons impinge on solid surfaces there are characteristic values of energy losses that form a kind of line spectrum of the energy distribution, for which he coined the expression "characteristic energy losses". The last few years have seen rapid development in the observation and interpretation of these energy losses, and the article by L. Marton, L. B. Leder and H. Mendlowitz (United States National Bureau of Standards) describes the wealth of information acquired.

This is followed by an article on sputtering by ion bombardment, by G. K. Wehner (Wright Air Development Center), a phenomenon which is little understood owing to lack of reliable quantitative yield data. The report on electrical discharge in gases and modern electronics, by L. Goldstein (University of Illinois), is confined to a survey of work during the past ten years and deals with the fundamental processes occurring in the volume of low-pressure weakly ionized gases at ordinary temperatures, using the new experimental techniques involving high-frequency electromagnetic fields and microwave methods.

The two remaining articles deal with widely different branches of electronics—observational radio astronomy and analogue computers. The first summarizes the main results concerning the Sun, our galaxy and external galaxies, and the observational methods used for studying the universe at radio frequencies, together with the physical and astronomical significance of the radio observations. The second is concerned primarily with the advances during the past five years in analogue computation, though a short historical summary is given of computer developments since the Second World War. Various sections deal respectively with components; computer systems, the larger of which such as TRIDAC and TYPHOON were developed for the solution of problems in guided missiles; and a variety of uses to which analogue computers are now being put.

S. Weintroub

SCIENTIFIC BACKGROUND OF TANNING

The Chemistry of Tanning Processes

By K. H. Gustavson. Pp. ix+403. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 9 dollars.

From time immemorial animal skins have been transformed by the tanning process into the fibrous and biologically stable product, leather. Recent research in the chemistry of tanning materials, proteins and the reaction between proteins, and substrates of small molecular weight, now permits the scientific investigation of tanning action, and a critical appraisal in book form of this progress should therefore prove opportune. This book by K. H. Gustavson deals with the chemistry of chromium salts and chromium tannage, the effect of neutral salts and complex-forming agents in chromium tanning, miscellaneous factors in chromium tanning, the nature of the chromium–collagen complex, vegetable tannage, the reaction of lignosulphonic acids and syntans (synthetic tanning agents) with collagen, aldehyde tanning, quinone and oil tannages, combination (chromium and vegetable) tannages, and some tanning reactions of biological and medical importance.

In the first half of the book, the author approaches chromium chemistry and tannage through the agency of electrometric titration, ion-exchange chromatography, ionophoresis and reaction kinetics. The results are interpreted in terms of the ionic and co-ordinate valencies of chromium, and of the functional groups and polypeptide backbone of collagen. Much of the research was initiated by Gustavson, who commands the reader's attention.

The review of vegetable tannins is, however, inadequate and out of date. Recent work (cf. Schmidt, O. T., and Mayer, W., *Angew. Chem.*, **68**, 103; 1956) has restored order and interest to the untidy field of vegetable tannin chemistry. Of the ellagic acid-free hydrolysable tannins, the constitutions of chebulinic acid and hamameli-tannin have now been elucidated, and a tetrasaccharide formula has been proposed for sumach-gallotannin. Among the ellagitannins, the structures of brevifolin, chebulagic acid, corilagin, and dehydrodigallic and valonic acids have also been elucidated. Recent application of conformational analysis to catechin and its epimeride deserves mention.

A lack of appreciation of the chemistry of vegetable tannins, particularly of gallotannin and of the constituents of myrobalans, is reflected in the subsequent treatment of their tanning action. Further, conclusions drawn from adsorption experiments involving crude tannin extracts and hide-powder exceed in scope the nature of the experiment. Although the phrase "multipoint contact" is frequently employed, there is no reference to Fischer's (1894) provocative "Einfluss der Configuration auf die Wirkung der Enzyme" which initiated the spate of studies on enzyme substrate-inhibitor and agonist-antagonist relationships throughout the succeeding half-century. This approach to tanning action might have been advantageously developed within the context of vegetable tannage. It is surprising that no reference has been made to the application of reaction kinetics to vegetable tannage, despite its obvious importance, and its successful application to the analogous dyeing of wool. There is an excellent summary of synthetic tanning agents.

The book concludes with a stimulating account of biological reactions which possess a possible tanning implication. The biologists' discoveries require critical assessment, however, as their materials are often detected histochemically by staining-reagents. Much of this work awaits intensive investigation by the natural products' chemist. In spite of its limitations, the book is the work of an enthusiast. Its chief merit is that it brings within small compass the salient references in the literature of leather chemistry.

D. E. Hathway

Yearbook of the Universities of the Commonwealth

Thirty-third Issue. Pp. lix+1925. (London: Association of Universities of the British Commonwealth, 1956.) 63*s*.

THIS useful handbook has been steadily growing in size with each new edition, that for last year being just over two thousand pages. If the new material that has accumulated since then had been incorporated without any adjustment of the existing contents, the present work would probably have been a hundred or more pages longer, and the volume would have been in danger of becoming unwieldy—a fault the magnitude of which is in direct proportion to the frequency with which the book is consulted.

Fortunately, the editor has taken steps to rectify this and, by a slight reduction in the contents, has managed to make this year's edition about a hundred pages shorter than the previous one. The three appendixes in the 1955 edition on postgraduate awards, Anglo–American academic relations and international university organizations, respectively, have been omitted, although the first one is available as a separate pamphlet. In the entry for each university headed "The Year", there are no longer the paragraphs on principal changes in regulations, adult education work, and visits by teachers; furthermore, those on benefactions, new buildings, and new departments and posts have been pruned.

This lopping, not of dead wood, but of branches that were not over-fruitful, has made room for some new growths—notably a new appendix on British academic institutions abroad, and an analysis, in many of the separate university entries, of the distribution of students by faculties. The new appendix covers three institutions: the British Institute in Paris; the British School at Rome; and the British School of Archæology at Athens. Thus it will be seen that the "Universities Yearbook", as it used to be entitled and is still commonly referred to, is very much alive and is likely to flourish for many a year to come.

The Birds of the British Isles

By Dr. David Armitage Bannerman. Vol. 5: Falconidae, Accipitridae, Aegypiidae, Pandionidae. Pp. xiii+350+34 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 63*s*. net.

WITH this fifth volume, Dr. D. A. Bannerman's scholarly survey of knowledge of British birds nears the half-way mark. There is here interpolated a brief memoir and a portrait of George Edward Lodge, the author's artist partner who died after the work had begun to appear. This tribute could not have been more fittingly placed, because his artistry was at its very best when birds-of-prey were his subjects; and within the same covers we have many outstanding examples of his work—incidentally, in several instances more than one plate of a single species, illustrating geographical or developmental differences in plumage.

The whole volume is devoted to the four families of diurnal birds-of-prey—falcons, hawks (in the widest sense), vultures and osprey; and that there are only some two dozen species will give an idea of the extent and detail of the treatment. The author quotes freely from others; but some of their material has not been published before and he has often facts to add from his own observations. Nowhere else would one find together so much information about the migrations and habits of each species, based on study at home and abroad. In respect of this group there is a wealth of observation of spectacular passages in some parts of the world; and the variety of hunting habits is of much interest, including the aerial 'pass' of food from the male to his mate exemplified by Montagu's harrier and by the hobby. The account of British status is too often a sad story of dwindling numbers and of a lost or precarious foothold. The use of certain species in falconry, once "the sport of kings", receives due mention.

LANDSBOROUGH THOMSON

The Number System

By Dr. H. A. Thurston. Pp. viii+134. (London and Glasgow: Blackie and Son, Ltd., 1956.) 15*s*. net.

DR. H. A. THURSTON has two aims in view: he wishes to explain to the intelligent non-mathematician the way in which the number-field is extended from the integers through the rationals to the irrationals and the field of complex numbers; he also wishes to give the student of mathematics a complete logical account of these extensions. He has therefore divided his book into two parts: the first half is a semi-popular discussion of the way in which needs to extend the number system have arisen and have been met, a broad and interesting general survey from which details have been omitted; the second half, similar to Landau's "Grundlagen der Analysis", gives the austere logical development, from the integers founded on Peano's axioms to the rationals as ordered pairs of integers, the irrationals as Cauchy sequences of rationals, and the complex numbers as ordered pairs of real numbers. But the two parts are closely interwoven; serious readers of the first part will surely wish to see a portion at least of the detailed working-out of general principles, while the young student will grasp the occasional logical twists of the second part more readily if he makes constant reference back to the more discursive explanations of the first part. The author has taken great pains with both parts, and does not appear to have fallen between two stools.

T. A. A. BROADBENT

Grignard Reactions of Nonmetallic Substances

By Prof. M. S. Kharasch and Otto Reinmuth. Pp. xxii+1384. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1954.) 135*s*. net.

THE Grignard reaction is now a major method in organic chemistry. The range of its application is very extensive, and it has an enormous literature. A real service has been rendered in the preparation of this book.

It is by no means a bare catalogue of reactions and a bibliography, although it includes both. It contains readable statements of the underlying chemistry, brief historical surveys, and (what is valuable) new suggestions on possible reaction mechanisms. Particular attention is given to grouping reactions so as to facilitate reference, and the literature references are very complete. In the case of Russian and Japanese papers, references to *Chemical Abstracts* are also given. The 'normal' reactions are defined in each case, and deviations from them are explained.

The volume is an outstanding contribution to chemical literature which should be available in every organic chemical laboratory, where it is likely to be in daily use. Although the price is high, the book is worth it.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

By RITCHIE CALDER, C.B.E.

EVERY year since the War, criticism of the British Association has been growing, and, forgetting resentments of much that was unfair in the strictures, the Council has decided, with the support of the General Committee, which is the membership body, to "put its house in order". Obviously, however, much more is involved than changing the structure and modifying the practices of a venerable institution, 125 years old. More than any other scientific body, the British Association brings almost the whole range of science within its scope and provides a forum for discussion with the public. To that extent, it has mirrored the complexities of modern science and the confusion of the lay attitudes to science.

When, therefore, the Council instructed an influential Committee, under Sir Ben Lockspeiser, "to consider the functions of the British Association in the present day world", it was in fact asking, in institutional terms, what Sir Raymond Priestley, this year's President, asked more rhetorically: "What can we do to help the world to make the choice which will ensure the survival and further progress of humanity?"

Perhaps the public and the critics expect too much of the British Association as an instrument for resolving their fears and confusions about science. But that is a tribute to its traditions and to the part which it has played, since 1831, as the meeting-ground and market-place of science. The complaint is about the presentation of science; but, allowing for the perennial faults of obscure, inarticulate and slipshod lecturing at the meetings, the blame does not rest entirely with that institution. The newspapers, radio and television cannot escape their responsibilities. But the British Association can help to remedy, by example, the more obvious defects in the scientists' approach to the public.

That has been recognized by the Lockspeiser Committee in its restatement of functions. It is realized, for example, that the Association can no longer provide a platform for the immediate proclamation of original discoveries. That function has been replaced by the learned societies and the scientific journals; no one to-day would hold up an important announcement until the annual meeting of the British Association. It is also true that one of the purposes of the British Association in its origins—to convince an indifferent public and government that science was important and worth backing—is now superfluous. Other urgent tasks, however, present themselves. To quote the Lockspeiser Committee's report: "Science has brought into being a new world, in which the peace and prosperity of all peoples are increasingly dependent the one on the other—dependent because the units of organization (social, economic, political and national) are larger and their control more centralized; a world whose structure is in this sense more rigid and yet one in which both individuals and nations must respond more flexibly and more frequently to the changing situations forced on them by the discoveries and applications of science. The continuance of science is vital to modern society and this being so continued public goodwill is essential. To ensure this the methods and results of science and the nature of fundamental research must all be better understood by those concerned with Government, industry and business and the public at large. Such understanding is essential because, in any democratic State, an informed public is necessary if valid decisions are to be taken; because the public—as taxpayer and consumer—pays for science; because if, in the future, scientists and technologists are to be forthcoming in the numbers that the nation's wellbeing demands, the public should learn to value the contribution of science and come to appreciate the potential satisfaction and opportunity for service implicit in careers devoted to science; and above all because scientific discovery must be applied for the wellbeing of the nation".

The British Association can make its contribution through its annual meeting, which still fulfils its original purpose of taking science to the people (at least in the big cities which can accommodate its many scientific sections and membership), and it still attracts representatives from every branch of science as well as industrialists, Government servants, agriculturists, teachers and a large representation of the Press, radio and television. The first concern of the Committee, therefore, was the re-definition of the function of the annual meeting.

First: it should offer a platform on which leading scientists can discuss their work in all its theoretical complexities so that the public may understand the integrity and discipline involved in the search for scientific knowledge, for its own sake. Second: it must recognize the dangers of specialization and fragmentation of science which has separated the scientists in the various branches and has made them practically unintelligible to each other and must bring them together in joint sessions so that they can share experience in related fields and recognize problems on the frontiers of present knowledge. Third: that it must provide for non-specialists, whether they be scientists outside their own field or interested laymen. It should provide an annual stocktaking in intelligible language which will review the progress of science and help to make clear its possible social and political consequences. To this end, prominent industrialists and political leaders should be invited to contribute to such sessions in order to put their problems in their wider setting.

The functions of the British Association are defined as "integration" and "dissemination". The integration involves bringing the specialists together to broaden their knowledge and their discussions beyond what is now possible in learned societies. The dissemination will involve a much closer relationship with the instruments of mass-communication—Press, radio and television—and the guidance of scientists as to how they can best serve or make use of popular presentation. Such reforms are badly needed although they may not suggest the 'revolutionary' changes which some of the critics might have wanted. The Committee, however, has recognized that the influ-

ence, and indeed the functions, of the British Association depends on its traditions.

The British Association relies on a small and inadequate office staff and upon the unpaid efforts of the officials of its fourteen sections and local officers in the centres of its annual meeting. The sectional committees, responsible for the preparation of the programmes, have persisted in virtual autonomy. The presidents of the sections, selected and honoured for their distinction, are appointed for a year, while the recorders, appointed for five years, and the secretaries, provide the continuity. Sections and section officials are jealous of their rights and privileges and, under the constitution, are entitled to resist any interference or dictation from the Council or the general officers. They are entitled, without reference, to choose their subjects and their speakers. The result is more than three hundred papers, of very uneven quality and content, crowded into four and a half days. Although one of the most important purposes of the British Association is to allow members to widen their interests by moving from one section to another (all meet simultaneously), there is a conflict of time-tables and interests.

During the 1930's the principle of joint discussions, where several sections joined together, was encouraged, and they were conspicuously successful. They have continued since the War, at the discretion of the sectional committees.

Against this background, the difficulties of co-ordination are obvious. Although the proposal of "conscious planning" was approved by the sections and the membership at Sheffield, there was outspoken distrust of any machinery to produce it. Guarantees had to be given that no pattern would be imposed from the top and that any co-ordinating would be done by persuasion and consultation. The Programme Co-ordinating Committee which has been appointed by the Council will therefore plan by consent. There will also be greater opportunities for advance discussions with Press, radio and television so that better material will be devised and better use made of it.

Perhaps more important than the refurbishing of the annual meeting are the proposals for making the British Association an active body throughout the year. The machinery for this has existed since 1938 in the form of the Division of Social and International Relations which, at the discretion of the Council, can meet anywhere, at any time, on any appropriate subject. Its original Committee (in 1938) included such men as Sir Frederick Gowland Hopkins, Sir Daniel Hall, Sir John Russell, Lord Stamp, Prof. P. M. S. Blackett, Prof. J. D. Bernal, Dr. Julian Huxley, Sir Alfred Egerton, Prof. A. V. Hill, Prof. L. Hogben, Prof. H. Levy, Lord Boyd Orr, Mr. H. G. Wells and Sir Solly Zuckerman. Its chairman was Sir Richard Gregory, and throughout the War, when he was president of the Association for six years, he kept the Association alive (although its meetings were suspended) by organizing conferences through the Division. Some of them, like that on "Science and the New World Order", were historic. International scientists were brought together in London, then subject to air-raids, to discuss momentous issues which are with us to-day, although the thinking about them is not as clearheaded as when the scientists and statesmen discussed them under the ægis of the Division.

Since the War, the activities of the Division have been restricted to occasional meetings or to sessions during the annual meeting. This comparative inactivity has been due to the financial difficulties of the Association and its lack of adequate staff.

A powerful new Committee of the Division has been appointed (and was the group which re-examined the functions of the British Association), and it is proposed that the Division should go out during the year to meet the industrialists, the farmers, the administrators, the trade unions, the women's organizations, and any other section of the community whose interests are affected by science. This break-down into common-ground discussions will give the British Association closer contact with reality and, it is hoped, with new sources of membership and finance. The British Association, like so many other institutions, has come to recognize that modern benefactors will finance specific projects and not, as in the past, endow a generalized ideal.

Given its 'New Deal' and the finances to implement it, the British Association can take on, yet again, a new lease of life.

UNITED STATES PROGRAMME FOR THE INTERNATIONAL GEOPHYSICAL YEAR

By Dr. JOSEPH KAPLAN

Chairman, U.S. National Committee for the International Geophysical Year, National Academy of Sciences

THE idea of international co-operation in the study of our changing physical environment is not new. The importance of geophysical data gathered intensively and simultaneously over large and relatively remote areas of the Earth was recognized in the last century in the conduct of the First Polar Year during 1882–83 and earlier this century by the Second International Polar Year, which took place during 1932–33. The proposed international effort for 1957 and 1958 surpasses in scope, intensity, and geographical coverage these earlier programmes, which were largely limited to the north polar regions and to but a few fields of geophysics.

The principal fields of study during the International Geophysical Year, 1957–58* will be aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, longitude and latitude, meteorology, oceanography, seismology, solar activity, and upper atmosphere rocket and satellite studies.

The proposal that 1957–58 be the time for this major international effort was based in part upon the fact that this period corresponds with a period of maximum solar activity. We shall be able to

* See Prof. Sidney Chapman's article, "The International Geophysical Year, 1957–58", *Nature*, Jan. 8, 1955, for a summary of the scope, aims, and methods of the project.

take advantage of this by a carefully planned series of 'alerts' and of 'special world intervals', occurring on such occasions as expected intervals of unusual magnetic, ionospheric, or auroral activity, days of solar eclipses and of abnormal solar activity, and unusual meteor showers. Special co-operative efforts on a world-wide scale will be made during these intervals to record the many phenomena which react to the complex activities of the Sun.

The current United States programme, planned and directed by the National Academy of Sciences, includes projects and programmes in all fields of the International Geophysical Year. This programme has considerable geographical as well as scientific coverage: the Antarctic, the Arctic, the Equatorial Pacific, and the continental limits of the United States represent the major regions of activity.

Long-range weather prediction and growth of knowledge of basic weather patterns will be greatly facilitated during the Year by the planned world-wide network of surface and balloon stations. The United States will conduct regular soundings to an anticipated height of 100,000 ft. at stations in Antarctica, the Arctic, South America, and the United States. We shall also maintain a Weather Central in Antarctica to collect and disseminate meteorological data to all interested groups both in and out of Antarctica, providing for the first time in history twice-daily weather maps of Antarctica.

As 1957–58 will be a period of maximum solar activity, scientists participating will develop detailed and comprehensive records in this field by means of systematic observations of the Sun with improved and faster co-ordination of the observing programme of solar observatories. Solar activity will be observed both in the visible spectrum and at radio frequencies. In particular, solar flares will be studied and correlated with changes in the intensities of cosmic-ray showers, ionospheric and auroral disturbances, and geomagnetic phenomena.

During the International Geophysical Year, a spectroscopic observation programme will give the distribution of radiations of the auroral spectrum both geographically and with respect to time during the auroral displays. The visual and photographic observations of the aurora have as objectives the creation of synoptic maps showing aurora distribution at small intervals and the collection of data for statistical studies of aurora with other geophysical phenomena and with solar phenomena. With modern techniques such as the all-sky camera, scientists will fill the gaps in knowledge about the aurora borealis in the Arctic, gather data heretofore unavailable about the aurora australis in the Antarctic, and trace the relationship between the two. The observing stations will be distributed along a longitudinal chain reaching from Arctic North America through Middle and Latin America to Antarctica. Measurements of the intensity of airglow radiations will also be made with photoelectric instruments of high sensitivity.

The source of cosmic rays and their possible effect on other particles and radiations in the outer atmosphere are far from adequately understood. During the International Geophysical Year, scientists expect to gain knowledge of the reasons for the large decreases of cosmic-ray intensity during some magnetic storms, fluctuations in cosmic-ray intensity near sunspot maximum, the world-wide variation of cosmic-ray intensity with the sunspot cycle, and the causes of sudden large increases of cosmic-ray intensity within an hour or less after the beginning of solar flares or chromospheric eruptions.

The ionosphere is studied chiefly by means of the radio waves which it reflects. Vertical incidence soundings will be taken at a number of sites in the United States and oblique incidence soundings both in the United States and in the Pacific area. There will be measurements of sporadic-*E*, backscatter by sweep and fixed-frequency techniques, and experiments in forward scatter. Radio noise and ionospheric absorption will also be measured, and there will be an extensive network of stations to study whistlers.

The United States geomagnetic programme consists of a series of experiments mainly designed to yield facts about the rapid fluctuations in the magnetic field, which are usually accompanied by disturbances in radio-wave propagation and often by auroral displays, and which also increase in number and intensity with an increase in the number of sunspots. To this end there will be a chain of geomagnetic stations stretching across the western United States in an east–west direction, another chain in Alaska in a north–south direction, and a third chain of four stations centred near the geomagnetic equator in South America.

Observations for the more precise determination of longitudes and latitudes will be made at twenty International Geophysical Year stations around the world. Astronomical longitudes and latitudes are obtained by observation of the positions of celestial bodies with respect to the direction of gravity. In the related programme on the position of the Moon, scientists using the Markowitz method will try to solve special problems in astronomy, geophysics, physics, and geodesy concerning universal and ephemeris time, the irregular rotation of the Earth, and the size and shape of the Earth.

The fragmentary nature of knowledge of gravity over vast areas in the oceans, the Antarctic, and the Arctic leaves considerable ambiguity about the shape of the Earth as a whole. The United States has therefore planned to carry out a number of gravitational studies. Gravimeter measurements are to be co-ordinated with the seismic exploration in the polar regions and can be carried out by the same personnel.

Seismological observations and measurements have long been conducted on an internationally co-operative basis. The United States programme includes additional measurements in remote areas, particularly in Antarctica and the equatorial Pacific islands. United States scientists will also attempt to measure linear strain directly with an instrument developed within the past few years by Dr. Hugo Benioff at the California Institute of Technology. There will also be projects to study the L_g phase wave and long-period seismic waves.

A study of motions of the deep currents in the sea, such as the vast exchange of polar water masses with those of warmer oceans, is related to problems of long-range weather forecasting. An island observatories project of the United States oceanography programme will be directed toward gaining an understanding of sea-level changes of both short and long periods and their relationship to other phenomena in the ocean and the atmosphere. 'Operation Deep Current', the other United States oceanographic project, will involve a study of the deep circulation of the water moving northward from Antarctica into and along the bottom of the Atlantic and Pacific,

and multiple-ship, detailed studies of the areas of convergence and divergence in the North Central Pacific and North Central Atlantic. These studies, as for all programmes in connexion with the International Geophysical Year, are co-ordinated with those of other nations.

The United States programme in glaciology will encompass detailed studies at points in the northern hemisphere and at stations in the Antarctic, as well as reconnaissance observations in the western United States, Alaska, and portions of the Arctic in co-operation with Denmark and Canada.

During the International Geophysical Year three approaches to obtaining direct upper-atmosphere data will be utilized: launching of large rockets from the ground, firing of smaller rockets from balloons and from aeroplanes, and launching of earth satellites. A total of more than two hundred rockets of different sorts will be launched by the United States for geophysical research purposes.

One of the limitations of the conventional rocket programme is that the rocket does not stay at great heights long enough to permit certain important types of measurements to be made. A single successful flight of a satellite will provide us with more observing time in the very high atmosphere than has been provided by all the ordinary rockets that have been fired.

Present plans call for the first earth satellite to be launched from the east coast of Florida at Cape Canaveral. There will be a three-stage rocket assembly to provide the means of placing the satellite in its orbit. When the satellite has reached a height of 300 miles, the last rocket will impel it into its orbit at a speed of about 18,000 miles per hour. The satellite will then revolve about the Earth in an approximate latitude range of about 40° on either side of the equator. Taking into account such factors as the Earth's rotation and the elliptical orbit of the satellite, its displacement will be about 25° for each revolution. This orbit will permit us to record observations over a broad expanse of the high atmosphere, while the latitudinal band-width coverage will permit scientists of a large number of nations to make observations and measurements.

The first satellite will be spherical in shape, about 20 in. in diameter, and will weigh approximately 21·5 lb. About half this weight will be required for the satellite itself, the remainder being available for instrumentation. At its closest point to the Earth it will be between some 200–300 miles distant, and at its farthest some 800–1,500 miles. Once placed in its orbit, the satellite becomes in effect a new celestial body. As such, the first problem becomes its acquisition—those preliminary observations which not only establish its existence in orbit but which also provide data for preliminary calculations of its orbit in order that ephemerides may be calculated and issued. These calculations will permit, first, the concentration of ground stations on the preliminary orbit and, second, the subsequent acquisition of more extensive data on the basis of which the various studies can be conducted.

The satellite programme thus affords an unusual opportunity for the acquisition of information about the upper atmosphere. As in other programmes of the International Geophysical Year, this opportunity is a broad one: the nations of the world will not only observe the satellite but will also participate in the scientific programme. The ground-station scientific programme, in particular, calls for extensive international participation in order to secure maximum advantage from the endeavour. Observations by radio or optical instruments will permit the conduct of important experiments relating to the density of the air of the outer atmosphere, the composition of the Earth's crust and various geodetic determinations. Moreover, it is hoped that other nations will be able to place satellites in orbit during the International Geophysical Year, increasing the amount of data thereby attainable and taking advantage of the interests, activities, and observing stations established during 1957–58 by the many participating nations.

PROGRESS OF CANCER RESEARCH

THE investigations described in the 500-page 33rd Annual Report of the British Empire Cancer Campaign covering 1955 can be divided into four categories, namely: (1) radiology, radiotherapy and radiobiology; (2) pathology and morbid histology and clinical themes; (3) carcinogenesis, statistical and demographic studies; (4) biochemical and biological lines such as those on nucleoproteins, cytogenetics, cytochemistry, steroid metabolism, tissue metabolism, viruses, cytotoxic agents, enzymes and hormones. It should scarcely be necessary to reiterate that in this short review only part of the large amount of research can be dealt with, and secondly that in such a wide field any reviewer is limited by his own experience.

The report affords an interesting cross-section of research at many centres into the vexed question of the relation between cigarette-smoking and cancer of the lung. The present position would seem to be summed up in a most interesting paradox: statistically, the case against cigarettes grows more and more convincing at the same time as, experimentally (at least so far as workers in Britain are concerned), it seems to grow thinner and thinner.

It would seem inescapable in the face of the formidable statistical evidence that cigarette smoke must contain something carcinogenic to the respiratory tract. Yet experimental proof of this is remarkably slow in appearing. At a number of centres the current experiment is to apply, to mouse skin, tar from cigarette smoke made in an apparatus which draws air through the lighted cigarette and condenses the smoke by passage through acetone cooled in a 'Drikold' bath. At none of six research centres have malignant tumours been evoked when the tobacco tar was applied to the mice. (These results are completely at variance with those of Wynder, Graham and Croninger in the United States, who obtained skin tumours in more than half the mice which were painted with tobacco tar.) Neither mice, rats nor hamsters have given positive results; nor have the different fractions from the tobacco tar obtained by separation with solvents shown activity.

It might be suggested that the disagreement with the American reports could depend upon some important difference in the technique of preparation of the tars or in the strain of mice employed for the tests. Since confirmation (or otherwise) of the report of Wynder *et al.* is urgently required, a thorough interchange of information and especially of materials, such as tobacco tars, tar fractions and mouse strains, should be instituted—and perhaps plans for such a liaison are already in process of being devised.

The lung of the rat has been used as the test material in experiments where either tobacco tar, or alternatively powerful carcinogens (benzpyrene, methyl-cholanthrene), were applied directly to the lung after thoracotomy had been performed. In forty-four rats only one carcinoma and seven sarcomas were obtained, indicating that the lung tissue of the rat is resistant to the carcinogenic potency not only of benzpyrene and methyl-cholanthrene but also of tobacco tar; the investigators were aiming at producing lung carcinoma of the type found in man, not at merely inducing sarcoma. None of the tumours was induced by the tobacco tar.

Tobacco tar injected directly into the lungs of thirty-six mice induced a low yield of lung tumour which was not very different from the incidence in the control untreated mice. In another experiment, soot containing nearly 100 parts per million of benzpyrene was used for direct injection into mouse lung. These experiments are not yet concluded; so far, the quantitative incidence of lung cancer could not be described as spectacular. Soot from railway engine funnels contains very little benzpyrene, whereas the soot from diesel engines which are operating slowly contains appreciable amounts of benzpyrene among other hydrocarbons.

The mortality-rates from respiratory cancer in Eire has been the subject of a very interesting investigation into the relation of tuberculosis to lung cancer in that country. Males in rural Eire have a low lung cancer-rate, less than a half of that in rural England. The data quoted afford plenty of material for speculation. For example, why was the Greater London lung cancer-rate (for 1953) 1,710 per million males at ages 45–64 and 4,125 at ages 65–74 years, while the corresponding rates for Dublin remained at 1,650 per million at ages 45–64 and 1,655 at ages 65–74? In 1953 the rate in rural England was 1,140 at ages 45–64 and only rose to 1,665 at ages 65–74 years.

The author states, "A study of the mortality rates per million for respiratory and non-respiratory tuberculosis and cancer from 1893 shows that apart from the disturbances due to the wars the sum of the mortality rates of the two diseases remains constant at 2,500 from the year 1910 onwards. It would appear that the mortality from respiratory tuberculosis has been replaced by that from non-respiratory cancer and that from non-respiratory tuberculosis by respiratory cancer".

Work on the relation of the atmospheric benzpyrene to smoking and lung cancer in Liverpool and nearby rural districts have shown that: "(1) rural death rate from lung cancer increases in proportion with the maximum number of cigarettes which have been smoked habitually per week, (2) Liverpool rates exceed the rural rates by about the same amount in each smoking category, (3) the urban/rural ratio between the death rates among non-smokers is about 9 to 1 and corresponds roughly with the ratio between the concentrations of 3 : 4-benzpyrene, some other polycyclic hydrocarbons and sulphur dioxide, found in the air of a Liverpool locality and the concentrations found in rural situations in Anglesey and Cheshire".

Stocks and Campbell's report just mentioned is a first-fruit of a major co-operative investigation into the environmental histories of patients dying of cancer of all sorts in North Wales and Liverpool. Data on 12,000 such patients and 19,000 controls are now available. Among other findings based on this series may be mentioned the following: (*a*) Cancer of the uterine cervix can be related better to early commencement of child-bearing than to numerous progeny. (*b*) Cancer of the stomach, in rural Wales where it has a high incidence, appears to occur most often in those who have lived for long periods over soil of high organic content. (*c*) Those with a high intake of beer (but not of milk or tea, the former appearing actually protective) have a raised incidence of most forms of cancer (but not, oddly enough, of gastric cancer).

This kind of survey, which depends for its success on the co-operation of many separate agencies, is one for which the British Empire Cancer Campaign seems particularly fitted. Another activity one would like to see it promoting more vigorously is the investigation of the geographical incidence of cancer, a subject on which even in its simplest aspects a remarkable amount of work remains to be done. There are accounts of only two activities of this type in this year's report. From Hong Kong come reports of investigations of two tumours of importance in that area. Hou describes the post-mortem appearances of infestation with *Clonorchis sinensis*, which he believes to be responsible for 15 per cent of liver cancers in the area. Teoh describes the nasopharyngeal tumours of Chinese, and comes to a firm conclusion that they are squamous carcinomata. In both of these, experimental investigations are under way; in the latter the possibility that incense smoke is the cause is being examined.

In Uganda a Cancer Registry has been set up, and has had the benefit of a visiting statistician. It is hoped to produce reliable statistics at least for one large district around Kampala. So far it has not gone beyond indicating that the true total incidence of cancer in the African is probably not very different from that seen in Europe. It has been possible to confirm roughly beliefs that cancer of the penis, liver, skin (especially Kaposi sarcoma) and uterine cervix are especially common, cancer of the respiratory and alimentary systems and breast relatively rare, and cancer of the testis, tonsil and thyroid apparently absent. Fuller reports from this Registry will be awaited with interest. One piece of work given little space in this Report, which could be a key to the incidence of liver cancer in the tropics, is the *Senecio* alkaloid studies of Schoental and Head.

The Great Ormond Street review of the tumours of childhood continues. This year's instalment is prefaced by some observations on the way in which improved treatment of other diseases is increasing the importance of tumours as a cause of death in early life. Though only 1 per cent of admissions to the hospital are for tumours, they are the cause of death of 17 per cent of cases coming to post-mortem, a figure second only to congenital malformations. Of the tumours nearly a third are intracranial, which are dealt with in some detail this year. The 203 tumours seen in this situation include 174 (86 per

cent) glial and 29 (14 per cent) non-glial—the latter consisting of eighteen meningiomata, six craniopharyngiomata, four choroid plexus tumours and one ependymoma. Bodian classifies the glial tumours into (differentiating) medulloblastoma (70 cases), nodular astrocytoma (59), diffuse astrocytoma (25) and subependymal glioma (20). (It may be noted that this makes medulloblastoma the fourth commonest tumour of childhood, or fifth if one includes leukæmia: neuroblastoma, Wilm's tumour and lymphoma stand above it.) Medulloblastoma and diffuse astrocytoma appear to be nearly always fatal. In the case of nodular astrocytoma, subtentorial meningioma and subependymal glioma, the prognosis is more encouraging and the results of treatment appear to be improving.

Further details of the study of the effect of treatment of neuroblastoma with vitamin B_{12} in massive dosage are given. Though only moderately encouraging, with 25 per cent of two-year cures, the genuineness of the effect would appear to be established.

In an experiment on the effect of environmental factors on cancer incidence, fowls were kept in a climatic chamber at constant temperature and humidity, while their siblings were exposed to the ordinary vagaries of climate; the diet was the same in both groups. The result of constant climatic condition was to increase greatly the incidence of cancer, for in the climatic chamber thirteen of nineteen fowls died and were found to have been suffering from adenocarcinoma of the ovary, oviduct, mesentary, alimentary tract, spleen, or liver. During the same period, only one death occurred in the control group (variable climate) and no cancer could be found at post-mortem. The fowls in the constant climate chamber were sexually inactive (that is, ceased egg-laying) for an average of 1·5 months in the three years of the experiment, while the control (variable climate) hens ceased egg-laying for eight months. These experiments suggest that a constant environmental temperature and humidity has a powerful effect on the reproductive cycle, and that in the fowl, cancer of the reproductive system and also of the alimentary tract, the liver and the spleen is facilitated by environmental factors via the endocrine organs.

Electron-microscope studies of the virus-induced Rous sarcoma in the fowl has made possible the first definite morphological identification of this virus. It has been shown to have a diameter of 70 mμ, but is not constantly detectable in all filterable Rous sarcomas. Obviously there are some interesting gaps in our knowledge of this tumour awaiting elucidation. From eight different Rous tumours, the 70-mμ particles were detected in four, and their occurrence varied from one particle-bearing cell in 2,000 cells to one in 50 cells. When the cells of the tumour were disintegrated mechanically so as to liberate the virus, it was found that there was a very close correlation between the sarcoma-producing activity of the tumour of origin and the percentage of cells which contained the 70-mμ particles.

The investigation of the carcinogenic action of cholesterol is continuing; recent reports from the United States have claimed that some oxidation derivatives of cholesterol have a much more powerful carcinogenic potency than the parent sterol. Fieser, Bischoff and collaborators state that solutions in sesame oil of lathosterol, 6-hydroxy-Δ^4-cholestene-3-one and particularly 6-β-hydroperoxy-Δ^4-cholestene-3-one all produce sarcoma in 30–60 per cent of injected mice.

An interesting example of species differences in sensitiveness to carcinogens has been demonstrated in the reaction of the tissues of the rat and of the guinea pig to 2-acetamidofluorene. The rat develops malignant tumours of the liver, kidney, ureter, bladder, pancreas, acoustic duct, mammary gland, uterus and skin; but feeding the compound to guinea pigs for as long as four years produced no tumours of any kind.

Interesting facts have been discovered in a study of the behaviour of normal and of malignant fibroblasts when these are grown in tissue culture. When the pseudopodia of normal fibroblasts touch each other, adhesions occur and movement ceases. On the contrary, when the pseudopodia of malignant fibroblasts touch, no permanent adhesion takes place; the cell surfaces slide over each other.

Berenblum's early work on co-carcinogens (now termed 'promotors') dealt chiefly with the polycyclic hydrocarbons, for example, benzpyrene or 1 : 2 : 5 : 6-dibenzanthracene, as 'initiators' which were applied in sub-threshold doses to mouse skin and then followed up by promotors, the most effective being croton oil, which behaves like a photographic developer in making visible the preliminary effect of the initiator.

This work has now been extended by other investigators to show that the entirely different compound urethane is a potent initiator for mouse skin and that croton oil is an initiator as well as a promotor. New initiators have been found; for example, one of the most effective is allyl methane sulphonate and also β-propiolactone; furthermore, applied in sub-ulcerative doses, the lactone is a complete carcinogen and produces papilloma and carcinoma. The detergent 'Tween 60' has been found to have promoting activity. The problem of relating chemical structure with carcinogenic potency thus becomes more complex as carcinogens (whether the compound is a complete carcinogen or is only a promotor or an initiator) of widely different structure become known.

Tobacco tar has been tested for co-carcinogenic activity and with positive results. Mouse skin pretreated (initiation) with benzpyrene developed papillomas when afterwards painted with tobacco tar, showing that the tar had a promoting effect.

In the ever-widening range covered to-day in research into the causes and treatment of cancer, the boundaries of the different fields of work become less distinct, and the physicist works in increasingly closer co-operation with his medical and chemical colleagues. Although the particular sphere of any one worker tends to become narrower, yet he is quick to make the most of the very varied tools available to him. This is well illustrated at one centre by the use of electron microscopy and autoradiography in the study of ultra-thin slices of tissues which contain carbon-14 or sulphur-35. A 1,000-curie cobalt-60 unit for the joint use of chemists, physicists and radiotherapists forms common ground for radiobiological research in another laboratory, and leads to the mutual discussion of other problems which are common to workers attacking the same basic problems from such widely differing approaches.

A considerable number of centres are installing, or have installed, sources of radiation of increasing penetration. Reports from various regions give details of measurements of the depth–dose distributions with 4–15 MeV. linear accelerators, and with

cobalt-60 sources. The effects of the inhomogeneity of body tissues on the dose received in the various tumour sites, and also the relative biological effect of the various qualities of radiations used in radiotherapeutic practice are being investigated.

Methods of calorimetric dosimetry are being perfected to enable an accurate measure of beams of high intensity but short duration, such as are met with when using the linear accelerator. Scintillation dosimetric techniques can now be applied with an energy response constant to ± 10 per cent over the range 20 keV. to 2 MeV.

At the other end of the activity scale, equipment has been constructed for the continuous monitoring of the natural radioactivity of the atmosphere, and regular measurements are being made of the radon content of the air in both hemispheres. Measurements have also been made of the natural radioactivity of different types of building materials from different parts of the world, and calculations carried out on the doses received at the gonads for both males and females. With the increasing development of radioactive materials, arising from a variety of uses from the luminescence of wrist-watches to the 'fall out' resulting from atomic explosions, the radiation dosage-level of the population as a whole becomes of increasing importance. This is confirmed in this report by the increasing use of radioactive isotopes, not as therapeutic agents, but as diagnostic and research tools, for labelling red blood cells with iron-59, for radiography with thulium-170 and xenon-133, and for diagnostic tests for thyrotoxicosis using iodine-131, to mention but a few of the numerous routine uses.

SCIENCE BY THE UPPER FORM

A SESSION of Section X (Assembly of Corresponding Societies) of the British Association meeting at Sheffield was devoted to a series of papers by sixth-form pupils under the title "Science by the Upper Form". Its object was two-fold: to introduce the young people to the meetings of the Association and to give adult listeners an insight into the work and interests of potential scientists.

The session was popular and attracted the largest audience that the Section enjoyed. The papers covered a wide range, from a consideration of the teaching of the history of science in schools to the mating customs of bullfinches, and from a school astronomical project to observations upon animal life in a stream. They were all indicative of much careful thought, and, where the subject demanded it, close and continuous observation combined with accuracy in recording. The young people were to be congratulated on their timing. None exceeded the limit imposed and some ended with a few minutes in hand.

The session was opened by Anthony E. Hanwell (King Edward VII School, Sheffield), who, under the title "The Value of the History of Science in a Sixth-form Science Course", gave an account of a course involving two periods a week for two years. The course began with the early attempts of man to exploit and adapt himself to his environment, all of which were characterized by the lack of a desire to seek theoretical explanations of the processes used. This was followed by attention to the study of Nature by the early Greek philosophers; to the Roman attitude to such matters; to the general decline in learning in the Dark Ages, and the impact upon European thought and life of the rise of Arabic nationalism and the recovery of the ancient Greek writings.

The course dealt fully with the lives of Copernicus, Tycho Brahe and Kepler, and the far-reaching effects of the work of Newton. Other sections were concerned with the histories of magnetism, electricity and light, to which a considerable amount of time was given; but it was surprising to learn that the history of biology was dealt with only in outline, and that of geology apparently not at all.

The speaker said that he was impressed by the way in which the study of the experiments of the pioneers emphasized the necessity for accurate observation. This in ordinary class-room work seemed directed mainly toward "obtaining a more accurate answer to a particular experiment, when if the answer were known it is usually possible to surreptitiously modify the observations". He appreciated the necessity for dealing with failures as well as with successes, and concluded that "a history of science course can do much to rectify the errors of undue specialization" by providing the scientist with a broader knowledge of his subject, its aims, its limitations, and its possibilities for good.

In a paper entitled "British Finches", Kenneth R. Hughes, of Chesterfield, gave the results of observations on three of the common species that he had kept under observation. The behaviour of some kept under aviary conditions was found to be identical with that of the wild birds. From accounts of mating displays, nest-making and brood-rearing it appeared that the courting of bullfinches began in mid-April and lasted for about a fortnight. Nest-building began soon after mating and when incubation commenced the cock was rarely seen near the nest, though he shared in the feeding of the young while the hen was sitting on her second clutch. When the birds of the second brood were able to feed themselves the whole family gathered and remained together until spring, changing their summer woodland habitat for gardens and allotments during autumn and winter. In March the flocks separated into pairs and the yearly cycle began again.

Hawfinches next received attention. The courtship was seen to be a vigorous affair in which the female seems almost to be driven to build a nest. The young are reared on insects, and it is only later that they become the enemies of fruit growers and gardeners.

The work is continuing, for Kenneth Hughes has seven other species under observation. He regards finches as suitable for his purpose on account of the ease with which they may be kept under conditions almost natural to them.

Miss Anne Bunting contributed a paper on "Some Little-known and Unpublished Aspects of the Life-History and Habits of *Periplaneta americana* (L.)". Having reared the large American cockroach for a number of years, she had come to the conclusion that the periods of incubation and of growth from incubation to final moult were shorter than is stated

in text-books. She found that the incubation period lengthens as the temperature decreases, that below 50° F. no incubation takes place, and that oothecæ submitted to this low temperature do not incubate if later exposed to more favourable temperatures. This was suggested as a partial explanation of the failure of the species to become widely established in Great Britain. Miss Bunting is a pupil of Thorne Grammar School, near Doncaster.

Keith L. Watson (Charterhouse) described "The Charterhouse Astronomical Project", the chief object of which was to revive within the school an astronomical society, first conceived when an observatory was added to the science laboratories in 1907. A retired master, Mr. R. C. Sclater, set up an observatory in his garden and made it a practice to invite parties of boys to make use of his telescope at week-ends. Unfortunately, he soon died and the project collapsed, to be revived again about four years later, in 1936. The organizers decreed that only sixth-form boys could become members—a rule that has now been wisely abandoned on the grounds that in order to maintain continuity with a changing school-population it is necessary to encourage the younger boys to take part. The work had to be suspended when war broke out and the observatory was used as a fire-watching post.

The present project was commenced in 1953 through the influence of a physics master, Mr. Hayward, and has been encouraged and assisted by a local medical practitioner, Dr. Lyne-Pirkis. To use Keith Watson's own words, "on a clear evening we are at liberty to telephone him and he picks us up in his car and takes us to his observatory where we always spend a very pleasant and instructive evening".

The work planned for the society is determined by the equipment available. The mirror of its original 6¼-in. reflecting telescope has been damaged, and since they cannot afford to pay for it to be repaired professionally the members intend to grind a new mirror for themselves. They now have also a 3-in. Cooke refractor, which, being simpler to use, is more popular.

Some of the boys are mapping portions of the Moon's surface, paying special attention to regions on the edge of the disk that, being difficult to observe and in many cases not very interesting, tend to be neglected by most astronomers. The main task of the solar section has been to plot the course and cycles of sunspots.

The society has about fifty members, but as with most local societies only a few are really active, the others being what Keith Watson aptly described as satellites, attending lectures but doing little practical work. It is interesting to record that a paper embodying observations on "Bee-eaters in Britain" was read by another Charterhouse boy, James J. Swift, at another session of the Section.

The last paper was on "The Ecology of Porter Brook", by John K. Chesters (High Storrs Grammar School, Sheffield). It was a description of work done on the headstream of the River Porter, which runs off the moors on the west side of Sheffield.

Animals were collected in a Surber net, the horizontal frame of which marked out one square foot of the bottom surface. The net faced upstream and collected all the animals loosened from the rocks and the bottom debris. The contents of the net were washed into jars and afterwards sorted, counted and identified.

A chart was prepared expressing the results of the count in terms of the distance in feet from the source of the brook and the months in which the samples were taken. This revealed interesting variations in the number and relative importance of several stonefly nymphs and chironomid larvæ in various parts of the brook and at various times of the year, and showed that annelid worms were found in large numbers near the source of the stream but not elsewhere.

As one of several examples of the results obtained, it was pointed out that the numbers of chironomid larvæ increased greatly (in April and May) at the junction of the Porter Brook with another small stream, the Mayfield. Since the larvæ live in the bottom organic debris and are liable to be swept away by fast bottom currents it was thought that their greater abundance in the combined stream was due to there being a relatively slower bottom current in the somewhat deeper water. Tests showed that on similar bottoms the bottom velocity above the junction was twice as great as below it.

The general conclusions arrived at were that the main factors affecting life in the stream during winter and early spring were the velocity and volume of the water, but that during the remainder of the year there were complications due to other factors such as the amount of vegetation overgrowing the stream and controlling not only the supply of higher plant material but also the intensity of illumination.

F. J. North

OBITUARIES

Dr. G. J. H. Swoboda

Gustave Swoboda, who died at Geneva on September 4, aged sixty-three, was widely known to meteorologists as the administrative head of the pre-war International Meteorological Organization and its successor, the World Meteorological Organization. Swoboda was a Czech (he later acquired Swiss nationality), a native of Prague, where he graduated in 1920 with the degree of Ph.D. In the same year he joined the State Meteorological Institute and ultimately became chief of the forecasting service. During this period he lectured on meteorology at the technical college in Prague and wrote a technical treatise on aeronautical meteorology. He was one of the first meteorologists outside Norway to give wholehearted support to the ideas of the Bjerknes school, and among other works he collaborated with T. Bergeron in a memorable essay on waves and vortices on a quasi-stationary surface.

The turning point in Swoboda's career came when he was appointed a member of the International Meteorological Organization's Commissions for Synoptic Weather Information and for Aeronautical Meteorology. The International Meteorological Organization was a non-governmental body, super-

vized by a conference of directors of various national services. Swoboda had, apart from his meteorological knowledge, one great asset for such international work. He was a very accomplished linguist, who spoke Czech and German as mother tongues, English and French with complete ease and had considerable knowledge of Dutch and several other European languages. It was therefore no surprise that in 1938 he was selected to succeed Dr. Cannegieter as chief of the secretariat of the Organization, and it was he who supervized the transfer of its headquarters from De Bilt to Lausanne.

Swoboda managed to hold the Organization together during the years of the Second World War and gained his reward in 1951 when the World Meteorological Organization, a Specialized Agency of the United Nations and the successor to the International Organization, appointed him as its first secretary-general. This post he held until September 1953 when he reached the normal age of retirement; but he continued to serve in an acting capacity until August 1955. At the time of his death he was professor of meteorology at Istanbul.

Swoboda's work as a scientist was recognized in 1953 when the Royal Netherlands Academy of Sciences awarded him the Buys Ballot Medal; but his unique contribution to meteorology undoubtedly was in the field of international co-operation. He was, in many ways, the ideal international Civil servant, and his success in this role arose as much from his kindliness and tact as from his linguistic gifts and administrative ability. He had not only a wide knowledge of his subject but also a great charm of manner and a genuine concern for the happiness and welfare of all around him. He leaves a widow and one son.

O. G. Sutton

Dr. C. B. Rees

Colin Bevan Rees died on September 2, a victim of cancer, at the early age of forty-one; and by his death marine biology has lost an enthusiastic and original plankton worker who was developing important new lines of research. Born at Pontardawe in Glamorgan on October 25, 1914, he was educated at Pontardawe Grammar School and University College, Cardiff. After graduating with first-class honours and making an ecological study of the fauna of the Severn Estuary, he was appointed in 1937 to the research staff of the Department of Zoology and Oceanography at University College, Hull, which was then expanding its plankton recorder survey. Jointly with Mr. K. M. Rae, he produced a report on the distribution of the Copepoda which was noteworthy for its account of the month-by-month advance of Atlantic indicator species into the North Sea from the north.

After war service as a captain in R.E.M.E., he returned to the plankton recorder team and moved with them to the new Oceanographic Laboratory of the Scottish Marine Biological Association at Edinburgh. He now conclusively demonstrated the reality of the previously disputed two forms of *Calanus*: *finmarchicus* and *helgolandicus*, and studied their distribution and development in different areas of the North Sea. Next he turned his attention to the planktonic larvæ of bottom-living invertebrates. He first set out to devise a method of identification for the multitude of lamellibranch larvæ; by using shape, form of hinge, and texture he distinguished seventy-seven types and produced an account, illustrated with diagrams and photographic plates, which has proved invaluable for other workers. A series of reports followed on the distribution of the larvæ of lamellibranchs, decapod crustaceans, echinoderms and other benthic animals. His University awarded him the D.Sc. in 1951. During his illness he made the final corrections to a further study of the two forms of *Calanus*, this time comparing their population production in the Atlantic and the North Sea over different seasons. He leaves a mass of data on the other copepod species which it is hoped may be prepared for publication later.

Colin Rees will be remembered by his colleagues and many friends for his devotion to research and for his cheerful good company. He was artistic and, as a hobby, painted in water-colour with distinction, exhibiting in leading Scottish galleries. Our sympathy goes to his widow and two children.

A. C. Hardy

NEWS and VIEWS

Brazilian Society for the Progress of Science

The annual meeting of the Brazilian Society for the Progress of Science was held this year during July 2–7 in the old gold-mining centre of Ouro Preto. The president of the Society, whose term of office runs for two years, is Dr. Anisio Teixeira, the distinguished Brazilian educationist, and the inaugural lecture was given by Prof. Carlos Chagas, the president for the meeting, on "Prospects and Problems of Scientific Research in Brazil". The subjects discussed at the meeting, which was attended by about two hundred Brazilian scientists, were divided into nineteen sections. The largest number of papers were presented in the four sections devoted to physiology (including biophysics, biochemistry and pharmacology); physics (and astronomy); microbiology (including epidemiology and preventive medicine); and chemistry. Papers on biological and medical subjects accounted for 65 per cent of the total of 211 papers presented. Foreign guests included Prof. A. M. Monnier, neuro-physiologist, Prof. J. L'Héritier, geneticist, both of the Collège de France, Prof. J. A. D. Cooper, biophysicist, of the University of Chicago, and Mr. F. M. Beatty, science officer of the British Council in Brazil, who lectured on the training of scientists and technologists in British universities. The next annual meeting of the Society will be held in Rio de Janeiro during July 1957; the 1958 meeting, celebrating the first decade of the Society's existence, will be more international and will probably be held in São Paulo.

Electronic Equipment working at Red Heat

A demonstration has recently been given at the Research Laboratory of the General Electric Company, Schenectady, N.Y., of electronic components and devices working at temperatures of red heat and, in some cases, under the action of intense nuclear radiation in an atomic reactor. Conventional electronic equipment usually breaks down at 200° F. or

above (about 100° C.), although with the advent of guided missiles and supersonic aircraft a number of components have been developed capable of operation at 500°–600° F. (about 300° C.). If high-speed flight is to make considerable advances in the future, bulky power-consuming equipment for cooling will have to be eliminated, and components must be capable of working at very much higher temperatures. By suitable choice of such metals as titanium and special ceramics, General Electric has developed—so far only at the laboratory-level—electronic components that function at temperatures up to 1,500° F. (about 800° C.) and also at a high temperature in the neutron flux of the graphite reactor of the Oak Ridge National Laboratory. Among the equipment shown at the demonstration were a radiogram and valve amplifier operating in an oven at 1,500° F., and an electric motor in the flame of a blow-lamp. In some respects, the new 'heaterless' valves are an improvement on the more conventional pattern in that the power supply normally required for heating the filament is eliminated, and it is thought that this new type of valve, if operating under constant high-temperature conditions, may have a superior performance.

The French Atomic Energy Programme

Issue No. 16 of *Laboratoires*, the quarterly review in French and English of French scientific and technical developments, is devoted to the French atomic energy programme, and in particular, to the peaceful applications of atomic energy and to France's participation in the International Conference on the Peaceful Uses of Atomic Energy held in Geneva last year. J. Guéron, director of the French Atomic Energy Commission, contributes a brief foreword in which he stresses the rapid expansion of the French atomic energy programme since the adoption in 1952 of a five-year plan for atomic equipment. Prof. Y. Rocard reports briefly on the Geneva conference and the associated industrial exhibition, and Prof. P. Auger follows with a most interesting article on the training of research workers in the field of atomic energy, in which he maintains that care should be taken to avoid the introduction of specialization directed towards the new fields of science and technology at too early a stage. It will be necessary to modify the university curriculum so that student engineers and scientists are made familiar with the new domains of physics, chemistry and biology which are now assuming major importance; but the practical aspects of particular applications should not be given excessive importance. They should form part of a training programme to be given later at specialized centres probably attached to the larger establishments where the technique is being employed. Future research workers and engineers should be encouraged to extend their basic knowledge to fields outside their own professional spheres; for example, the chemist to radioactivity, and the mathematician to nuclear physics. In addition, Prof. Auger emphasizes the importance to the atomic scientist and engineer of ancillary services, the provision of an adequate number of trained technical assistants, a good information service and library, and the time and facilities to attend scientific meetings and conferences and for visits to other research establishments. Other articles in the issue are on automatic instruments for recording radioactivity, by Prof. P. Bonet-Maury, and on analogue computor simulation of the kinetic performance of nuclear reactors, by J. Girerd. Finally, there is a detailed illustrated technical review of the various exhibits of French instruments and equipment displayed by the forty-six French firms which took part in the international exhibition at Geneva last August.

Studies of the Upper Atmosphere

One of the classic works of meteorology is W. H. Dines's discovery (M.O. Geophys. Mem. No. 13; 1919), using his balloon-sonde observations, of the positive correlation between temperature in the troposphere, pressure in the upper troposphere, and the height of the tropopause and the negative correlation between these quantities and temperature in the stratosphere. Thus low pressure in the upper troposphere goes with a cold troposphere and a low tropopause. This discovery was the death-blow to the convective theory of temperate-zone depressions, which required depressions to be relatively warm. Using recent radiosonde observations, J. K. Bannon and A. Gilchrist (*Quart. J. Roy. Met. Soc.*, **82**, 58; 1956) have repeated and much extended Dines's work. Bannon and Gilchrist used radiosonde observations at Arctic Bay (North Canada, lat. 73° N.), Lerwick, Larkhill, Malta, Aden and some equatorial Pacific stations for heights up to the level where pressure is 60 mb. (about 63,000 ft.). They confirmed Dines's results for the Lerwick and Larkhill observations and found the same result for Malta in winter and Arctic Bay in summer and autumn. At Aden and the equatorial stations and at Malta in summer no correlation could be found, and at Arctic Bay in winter and spring the correlation was less marked than at the British stations. Malta in winter and Arctic Bay in summer and autumn have a similar meteorological regime of travelling depressions and anticyclones and changing types of air-mass to that of the British Isles throughout the year. In summer, however, Malta is mostly in the area of the subtropical anticyclone, and Arctic Bay in winter and spring is in the area of a fairly constant low-pressure area with little change of air-mass. The conclusion is that the Dines correlations are characteristic of travelling depressions and anticyclones with frequent changes of air-mass. Dines evaluated correlations between tropospheric temperatures and pressure up to 9 km. (30,000 ft.). Bannon and Gilchrist found the correlation decreased rapidly at greater heights, so that the influence of travelling depressions and anticyclones was only half at 60 mb. what it was at 150 mb. (about 45,000 ft.).

Photometry of Telescopes and Binoculars

The booklet "Photometry of Telescopes and Binoculars", which is No. 14 in the series of "Notes on Applied Science" produced by the National Physical Laboratory, Teddington (pp. 18+2 plates. London: H.M.S.O., 1955; 2*s*. net), explains the objects and methods of some of the test work performed for industry by the Laboratory. The quality of a telescope is judged by its definition, that is, its power of producing a sharply defined image of a distant, often inaccessible, object; but this quality is extremely difficult to express quantitatively and is not dealt with in the booklet. However, closely connected with definition is the question of contrast. If there is little difference in contrast between an object and its surroundings and the contrast-rendering properties of the telescope are poor, the image may be undetected. Veiling glare is a measure of the light scattered or reflected in the instrument which, falling

on the image, reduces its contrast. Light transmission, the percentage of light transmitted in the central portion of the field of view by the optical parts of the telescope, is obviously also of importance in assessing the general performance of the instrument, in addition to field brightness, which gives a measure of the falling-off in illumination towards the edges of the field of view. The booklet describes in some detail the apparatus developed and used at the Laboratory for making measurements of the axial light transmission, the veiling glare index and the field brightness of telescopes and binoculars. The apparatus for the last-named measurement is still in prototype form.

Guide to the British Museum (Natural History)

It is interesting to compare the general format of the publications of the British Museum (Natural History) issued at the present time with those of, say, twenty years ago. Then an austere approach to the subject in strictly traditional covers repelled all but the most ardent of students; but to-day the "Short Guide to the Exhibition Galleries of the Natural History Museum", now in its fourth edition (pp. 28; 1956; 1*s.* 6*d.*), is in an attractive coloured and original cover and invites even the least interested in museums to glance at the contents. Following a brief historical introduction, the "Guide" describes in outline contents of the Central Hall and its five bays. Attention is then directed to a set of cases introducing the five Departments of the Museum—Zoology, Entomology, Geology, Mineralogy and Botany. The reader is quickly led through the Departments, and the special features of each are described in a few—in some cases dramatic—words. The "Guide" includes a table giving the geological time-scale and some general information concerning the Museum and its main activities. This indeed is a booklet which can be used equally as a guide during a visit to the Museum and afterwards as a reminder of the objects seen.

The Gila Monster of North America

The Helodermatidae are marked off from other lizards by the possession of grooved teeth in the lower jaw and of poison glands. The most widely known species is the gila monster, about which a number of myths and tales have gathered. Charles M. Bogert and Rafael Martin del Campo have made an exhaustive investigation into the natural history and ecology of the family and produced an interesting memoir (*Bull. American Mus. Nat. Hist.*, **109**, 238+20 plates; 1956; 4 dollars). It does not deal with the anatomy except for a brief reference to the lower jaw, the arrangement of the bones of which provide a specific differentiation. The authors recognize two distinct species, *Heloderma horridum* and *H. suspectum*, which are distinguishable by definite external characters and have different distributions. *H. horridum* with three subspecies, each occupying its own area, is found on the Pacific drainage of Mexico, and it is suggested that it should be called the beaded lizard from the characteristic appearance of the skin: it is known in Mexico as the escorpión. It was first mentioned by Hernández in 1615. The other and better-known form is the gila monster, *H. suspectum* with two subspecies, found from just inside Mexico northwards into central Arizona. It has been shown experimentally that heloderms secrete a poison that is quite lethal to a wide range of animals including the common laboratory types. The authors have traced thirty-four recorded cases of gila monsters having bitten human beings, and in eight of these death was stated to have followed; but the actual records are not satisfactory, and in some there were contributory factors. The possibility cannot be ruled out, but the poison mechanism is not efficient, and it is probable that only in exceptional conditions could sufficient poison be injected to prove fatal. In the chapter dealing with myths there is an amusing tilt at the ardent systematist in the setting up of a genus *Sampoderma* for a creature described by a Mr. Holmes and a Dr. Watson from a locality near Baker Street.

Overseas Students at British University Institutions

Appendix III of the 1956 "Yearbook of the Universities of the Commonwealth" gives the number of overseas students enrolled for full-time study or research in British universities and university colleges at the beginning of the academic year 1954–55 as 9,050, of whom 1,261 were women, compared with 8,619 in 1953–54 and 6,264 in 1938–39. Of these, 5,575 came from other parts of the British Commonwealth, including 346 from Australia, 372 from Canada, 238 from the Gold Coast, 1,229 from India, 173 from New Zealand, 700 from Nigeria, 319 from Pakistan, 193 from Malaya (with 60 more from Singapore) and 491 from South Africa. Arts claimed 3,741 students, technology 1,799, medicine 1,597, pure science 1,316, dentistry 311, agriculture and forestry 214, and veterinary science 72. Excluding external students, London had 3,454 overseas students, Cambridge 820, Oxford 855, Edinburgh 683; but of the rest only Durham (356), Leeds (348), Manchester (393) and Glasgow (313) had more than three hundred. Outside the Commonwealth, the United States provided 820 students, and Egypt 306.

Guide to the Manchester Libraries

The North-Western Group of the Reference and Special Libraries Section of the Library Association has published, under the title "The Libraries of Greater Manchester" (pp. 92; 1956; 15*s.*), a guide to the resources and special collections of the region which both shows the wealth of recorded information available in the area and also the appropriateness of Manchester on this count alone as a regional centre if the Government ever attempts to develop a national library system, at least for science and technology. As Mr. L. L. Ardern, chairman of the North-Western Group, explains in an introduction, the guide is based on the 141 returns received to a questionnaire which was sent to all likely societies. Mr. Harold Smith's editing has provided a work which is both clear and concise and should enable the student or expert seeking information to decide readily which of the many libraries of the area is most likely to be able to help him; at the same time, it should minimize the chance of a library being troubled with a request which it is unable to meet by reason of its holdings and scope or on constitutional grounds. The guide is well produced and should materially assist in library co-operation and the more effective use of regional resources.

The Night Sky in October

New moon occurs on Oct. 4d. 04h. 24m., U.T., and full moon on Oct. 19d. 17h. 24m. The following conjunctions with the Moon take place: Oct. 1d. 02h., Venus 5° N.; Oct. 2d. 18h., Jupiter 6° N.;

Oct. 7d. 20h., Saturn 2° N.; Oct. 16d. 15h., Mars 9° S.; Oct. 30d. 11h., Jupiter 6° N.; Oct. 30d. 21h., Venus 6° N. In addition to these conjunctions with the Moon, Venus is in conjunction with Regulus on Oct. 5d. 14h., Venus being 0·4° S., Venus with Jupiter on Oct. 25d. 14h., Venus being 0·2° N., and Mercury with Spica on Oct. 26d. 09h., Mercury being 4° N. Mercury can be seen before sunrise during the middle of the month, rising at 4h. 45m. on October 15. Venus rises at 2h. 0m., 2h. 30m. and 3h. 15m. on October 1, 15 and 31, respectively, and is very bright, its stellar magnitude being about −3·7; its distance from the Earth is increasing throughout the month, from 87 to 106 million miles, and the visible fraction of the apparent disk also increases, from 0·65 to 0·75. Mars rises at 17h. 20m., 16h. 15m. and 15h. 05m. on October 1, 15 and 31, respectively, and sets at 3h. 30m., 2h. 35m. and 1h. 50m. on the following mornings; its stellar magnitude decreases during the month from −2·2 to −1·3. Mars was at minimum distance from the Earth during September and is now getting farther away, being at 53 million miles by October 31; it is near ψ Aquarii throughout the month. Jupiter rises at 4h. 05m., 3h. 30m. and 2h. 45m. at the beginning, middle and end of the month, respectively; at the beginning of the month it is near σ Leonis and moves into Virgo, being near β Virginis at the end of the month. Saturn sets at 19h. 30m. on October 1, and is too close to the Sun for satisfactory observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Oct. 14d. 20h. 28·3m., c^1 Cap. (*D*); Oct. 22d. 23h. 05·4m., 129 H^1 Tau (*R*); Oct. 27d. 03h. 27·6m., A^1 Cnc. (*R*); *R* and *D* refer to reappearance and disappearance, respectively. The Orionid meteors are active during October 15–25, but conditions are unfavourable; the radiant is near R.A. 6h. 24m., Dec. 15° N. Taurid meteors may be seen during the last few days of the month; conditions are favourable and the radiant is near R.A. 3h. 36m., Dec. 14° N.

Announcements

THE Messel Medal for 1956 of the Society of Chemical Industry has been awarded to Sir Alexander Fleck, chairman of Imperial Chemical Industries, Ltd. The Medal will be presented to Sir Alexander at a special meeting of the Society on October 12 at 6.30 p.m., held in the Royal Institution, Albemarle Street, London, W.1, when he will deliver an address on "The Chemical Industry: Some Achievements; Some Problems".

MR. L. A. WISEMAN, who is at present working at the Atomic Weapons Research Establishment at Aldermaston, has been appointed deputy director of the British Rayon Research Association.

THE following appointments have been made in the Department of Chemistry of the University of British Columbia, Vancouver: Dr. J. Halpern, associate professor; Dr. H. G. Heal, assistant professor; and Dr. G. Porter, instructor.

SIX transfer scholarships provided by Imperial Chemical Industries, Ltd., have recently been awarded to sixth-form boys for study at the University of Liverpool. The scholarships are specially designed for those who have specialized in arts subjects at school but who wish to pursue scientific studies at a university, and they cover a one-year course of intensive preliminary training in the basic sciences as a preparation to study for a degree in science (see *Nature*, March 31, p. 606). In general, the scholarships are tenable at the Imperial College of Science and Technology, London, King's College, Newcastle upon Tyne, and the Universities of Cambridge, Liverpool and Oxford.

THE Chemical Society invites applications for the Corday–Morgan Medal and Prize for 1955, for work in experimental chemistry, published in that year, by a British person who at the time of publication was less than thirty-six years old. The award consists of a silver medal and prize of 200 guineas. Details of the application, to be made by December 31, and further information can be obtained from the General Secretary of the Society at Burlington House, London, W.1.

A HARRISON Memorial Prize, not exceeding 100 guineas, is being offered this year for chemical research over the past five years by a natural-born British subject not more than thirty years old. The selection will be by a committee consisting of the Presidents of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society. Details of application, which must be made by December 1, and further information can be obtained from the President of the Chemical Society, Burlington House, Piccadilly, London, W.1.

THE Royal Commission for the Exhibition of 1851 is increasing the value of its awards for scientific research, and as from October 1 the senior studentships for workers recommended by universities in Great Britain will be £800 a year and the overseas scholarships for students from universities of the British Commonwealth (and Eire) will be £550 a year; in each case, annual grants of up to £100 a year for approved fees and expenses will be available.

A CONGRESS on "Rockets and Guided Missiles for Continental Connexions and Telecommunications", together with an exhibition of rockets and guided missiles and their associated equipment, will be held in Paris during December 3–8 under the auspices of the Association pour l'Encouragement à la Recherche Aéronautique. The congress will be international in scope and will be broadly divided into two groups on scientific and technical studies and on economic studies, respectively. Further information can be obtained from A.E.R.A., 1 rue de Courty, Paris 7e.

AN international conference on "Operational Research", organized by the Operational Research Society (Great Britain), the Operations Research Society of America and the Institute of Management Sciences (United States), will be held in the University of Oxford during September 2–6, 1957. There will be four sessions on the common themes in operational research; methodology; and applications (two sessions). Those wishing to read papers should send summaries in duplicate, and not more than two hundred words in length, not later than November 30 to either Dr. Thornton Page, Operations Research Office, 7100 Connecticut Avenue, Chevy Chase, Maryland, or to Mr. B. H. P. Rivett, Operational Research Society, 2 Grosvenor Place, London, S.W.1.

ERRATUM.—In the article on "The 1956 Cambridge Summer School in Physical Chemistry", published in *Nature* of September 15, on p. 578, eleven lines from the bottom of column 1, for "carbon monoxide" read "chlorine monoxide".

MICROSCOPY WITH X-RAYS

SYMPOSIUM IN CAMBRIDGE

IN the sixty years since the discovery of X-rays, very wide use has been made of them in industrial and medical radiography. These macroscopic studies of internal structure have proved of value both in research and for purposes of non-destructive testing. Only comparatively recently, however, has attention turned to the value of X-rays for microscopic investigation, and real progress towards a resolving power of optical order has had to wait until the post-war decade. Refinement of the normal radiographic technique, by using photographic emulsions of high resolution, has been accompanied by the development of a point projection method and by the use of reflecting mirrors to form an instrument more nearly akin to an optical microscope. The very short wave-length of X-rays, compared with visible light, holds out the ultimate prospect of a greatly improved resolution; but a more immediate advantage lies in the ability to examine specimens that are opaque at the usual optical wave-lengths. With X-rays it is also possible to get good micrographs from much thicker sections of transparent materials than can be tolerated in the optical microscope, on account of its very small depth of focus at high magnification.

These prospective advantages, as well as interest in the physical principles involved, have stimulated an increasing interest in the use of X-rays for micro-structural investigation. To bring together those actively working in the subject, a symposium on X-ray microscopy and microradiography was held in the Cavendish Laboratory, Cambridge, during August 16–21. It was sponsored by the International Union of Pure and Applied Physics, and received financial support from the United Nations Educational Scientific and Cultural Organization and from a number of industrial concerns in Britain. The response to its announcement was much greater than anticipated. In addition to those from the three main centres of activity, in Stanford University, California, the Caroline Institute, Stockholm, and the Cavendish Laboratory, participants came from nine other countries and papers, to be read in absence, from two others (Uruguay and the U.S.S.R.). In all, there were 125 members of the symposium and sixty-six papers were read.

The symposium was opened by Prof. N. F. Mott, as president of the International Union of Pure and Applied Physics and head of the Cavendish Laboratory. A general survey of the use of X-rays for microscopy by Dr. V. E. Cosslett (Cambridge) was followed by introductory accounts of the three chief methods: of the grazing-incidence reflexion technique by Prof. P. Kirkpatrick (Stanford), of contact microradiography by Prof. A. Engström (Stockholm) and of the projection method, using a point-focus tube, by Dr. W. C. Nixon (Cambridge). The following two days of the meeting were devoted to the problems of each technique in turn, including the special needs of micro-diffraction and of quantitative analysis by absorption, emission and fluorescence spectrometry.

Conditions of grazing incidence are new in optical theory. Considerable progress has been made at Stanford in the design of the form of aspheric surface best calculated to provide a practically useful compromise between width of field and resolving power. A four-mirror system computed by Dr. H. H. Pattee (Stanford) should give a resolution of 500 A. over a field of at least 20μ with X-rays of wave-length 4 A. However, to obtain this performance, the mirror contours must be true to within 50 A. and, to reduce scattering to a sufficiently small value, the surface must be molecularly smooth. The immediate problems therefore lie in the working and testing of mirrors and, once they have been made, in their precise alinement. New techniques were described for these purposes, as it is not enough simply to refine existing optical methods. An experimental microscope, reported by Dr. J. F. McGee (Stanford), incorporates two uncoated silica mirrors and two adjustable aperture stops. Using aluminium radiation (8 A.) a resolving power between 0·5 and 1μ has been obtained. In these systems the mirrors of an imaging pair are axially separated. M. Montel (Laboratoire de Chimie-Physique, Paris) has devised an elegant method of sectioning spherical mirrors and uniting two half-mirrors at the appropriate mutual angle, so as to eliminate astigmatism and anamorphism.

By contrast with reflexion microscopy, which is faced with severe technical problems, the contact method of microradiography is limited in performance only by the effective grain size of the photographic emulsion. The development of emulsions of resolving power 2,000 lines/in. now permits microradiographs to be obtained with a resolution approaching that of the best optical microscope. Prof. Engström described his work with softer X-rays (200–2,000 V.) than those usually employed. X-ray pictures of chromosomes and other cell components were shown which had a resolution of 0·3–0·5μ. An X-ray tube specially developed for these wave-lengths was described by Prof. P. J. Fitzgerald (College of Medicine, State University of New York), and an adapted commercial tube by Dr. A. Recourt (Philips, Eindhoven). Dr. B. L. Henke (Pomona College, California) has developed a tube having a gas-discharge type of electron source and a reflecting mirror for X-rays of 10–100 A. wave-length, in order to obtain better intensity in a region where efficiency of X-ray production decreases rapidly.

The point projection type of X-ray microscope, using magnetic lenses to obtain an electron spot as small as 0·1μ, was discussed by Dr. W. C. Nixon (Cambridge), Dr. J. B. Le Poole and S. P. Ong (Technical University, Delft) and Prof. B. M. Siegel (Cornell University). A resolving power approaching that of ultra-violet microscopy has been obtained by Nixon, with an exposure time of about 1 min. Smaller electron spots, certainly down to 100 A., can be obtained, but only with rapidly decreasing X-ray output, since the final electron lens has to be stopped down because of high spherical aberration. The need to increase the intensity of the electron beam, in compensation, was discussed by several authors. Dr. B. M. Rovinsky (Institute of Machine Sciences, Moscow) described a tube with ring cathode and needle-point anode, and the converse system using a point cathode and field emission was discussed by Dr. Pattee and by Dr. L. Marton (National Bureau of Standards, Washington, D.C.). The former has

obtained high emission, but only at very high vacuum; the latter has worked at the vacuum more usually prevailing in a demountable apparatus, obtaining so far only small beam currents. In view of the difficulty of obtaining stable field emission in such circumstances, it appears at present that the best prospect for increased intensity in the point-focus tube lies in correction of the spherical aberration of the magnetic lens. The projection method has the advantage of direct enlargement on normal emulsions, but at cost of small field of view; the contact method gives a large field, but has greater difficulties of specimen preparation (since the specimen has to be very thin and placed almost directly on the emulsion) and of photographic processing. Even if a grainless film of reasonable speed can be developed, the optical viewing system will impose a limit on resolution—unless the emulsion can be stripped and viewed in the electron microscope. A possible technique of this nature was described by Dr. W. A. Ladd (Ladd Research Industries, New York), in which the 'emulsion' is a plastic film in which X-rays produce solubility changes depending on amount of exposure.

Even though X-ray methods may equal and perhaps exceed the optical resolving power, their main value in biology is likely to lie in the ability to distinguish different elements in the specimen, by means of differential absorption, emission and fluorescence. A large number of contributions was devoted to these methods of quantitative analysis. The Stockholm school has investigated in detail the accuracy attainable in absorption spectrophotometry, utilizing the characteristic absorption edges of the different elements. Dr. B. Lindström reported on analysis of sulphur and phosphorus in biological material, using a new high-vacuum apparatus and soft X-rays, and Dr. G. Wallgren described his studies in the mineralization of developing bone in human embryos. By direct microphotometry, analyses can be carried out on areas of tissue down to $3\mu^2$; a scanning and computing instrument for this purpose was described by Dr. O. Hallen (University of Gothenburg).

The projection method can also be adapted to microanalysis, and is especially useful for areas smaller than a few square microns, since photometry or photon-counting is carried out directly on an enlarged image. Mr. P. Duncumb (Cambridge) dealt with the design and operation of a flying-spot system for the analysis of thin layers by X-ray emission: the characteristic lines are detected and their strength measured by a proportional counter. An accuracy approaching 1 per cent can be obtained with a spot 1μ in diameter, and neighbouring elements in the periodic table can be separated if a crystal spectrometer is used. Mr. J. V. P. Long (Cambridge) described the adaptation of a projection X-ray microscope for the analysis of selected regions of a specimen, under a stationary spot, by fluorescence, absorption or emission methods at will. In emission, the specimen can simultaneously be viewed in transmitted light by an optical microscope. The limits of microchemical analysis by these methods were discussed by Prof. A. V. Baez (Redlands University, California). A detection limit of 1 per cent in a volume of $1\mu^3$ is equivalent to a mass sensitivity of 10^{-14} gm. of substance of unit density. At the moment, it is possible to determine elements of medium atomic number, down to aluminium or perhaps magnesium. Prof. Engström and Dr. Henke discussed the practicability of analysing separately the carbon, oxygen and nitrogen content of biological tissues with very soft X-rays, and it appears that this may be done with an accuracy of 5–10 per cent. Such a technique will be of revolutionary value in cytochemistry, just as the qualitative results obtained with microradiography are creating a new subject of microanatomy.

The sessions on applications of X-rays to microscopy, at the moment primarily using the contact method, covered a very wide range of subjects at the symposium. In biology, reports were presented of work on plant cancers and the growth of inorganic crystals in leaves, on the progress of osmium fixation in tissues, on the microstructure of wood and on insect flight musculature. In the medical field, investigations were reported of cancer of the breast and of the cervix, the human eye, the vascular patterns of human muscle and skin, growth of stone in the kidney and the embryonic stages of dentition. New techniques are now making it possible, particularly with the projection method, to observe changes in living tissue under experimental treatment. The metallurgical session was shorter, but contained accounts of the use of microradiography in studying segregation effects in ferrous metals and in light alloys, especially of aluminium, and the growth of oxide films. Preliminary studies of the distribution of heavy elements in rock sections were also reported.

Some discussion took place, formally and informally, on the need for further meetings on the subject of X-ray microscopy, for a specialized abstracting service and for clearing up matters of terminology. A small committee was set up to look into possible forms of organization, with particular regard to existing bodies and the need for connexion with the International Council of Scientific Unions. Its report will be prepared in time for discussion at the next symposium, which it is hoped to hold in Stockholm in 1959.

V. E. Cosslett

THE EIGHTEENTH INTERNATIONAL GEOGRAPHICAL CONGRESS

THE eighteenth International Geographical Congress was held in Rio de Janeiro during August 9–18. The 1,006 delegates actually present included nearly four hundred from overseas, representing more than forty countries. The first congress was in 1871, yet this was the first to be held in the southern hemisphere, the first in the Tropics and the first in Latin America. It was opened in a blaze of pageantry by the President of Brazil in person at the Municipal Opera House. The delegates were welcomed by the President of the Organizing Committee of the Brazilian National Committee for Geography, and the British President of the International Geographical Union (Prof. L. Dudley Stamp, elected at Washington in 1952) gave a précis of his presidential address on the "Measurement of Land Resources". In order to secure some more precise measure of the capability of different types of land in differing climates and under differing types of management to support human life, he suggested the introduction of a 'Standard Nutrition Unit' of 1,000,000 calories annual production or 900,000 calories of net annual consumption. It was shown that a varied diet based largely on meat may require 3½ acres or more to

produce one such unit, whereas with an extreme concentration on high-calorie foods (for example, rice and sweet potatoes) and intensive multiple cropping, as many as 6½ units per acre are produced in Japan, or more than twenty times as much.

At the first session of the General Assembly, four countries were elected to full membership—the U.S.S.R. (which had sent a strong delegation), Iceland, Hungary and Ethiopia. This was the first participation of the Russians since before the Second World War. With the object of helping the development of geographical research in countries with an insufficient number to set up the National Committee required of adhering nations, the General Assembly added to the Statutes provision for a class of Associate Members and elected as such the Sudan, French West Africa, Nigeria, Uganda, Kenya and Iraq.

More than three hundred papers, printed in abstract in advance, were presented to the dozen working sections into which the Congress was organized. Much attention was also given to the presentation and discussion of commission reports. At each Congress, the General Assembly, with the guidance of the Executive Committee, appoints commissions, consisting of not more than six full members, to carry out investigations into specific problems. Each commission must present a report at the next Congress, but may be reappointed for a further term. Reports presented were those on Medical Geography (which also had an active and flourishing section dealing both with the geographical distribution of disease and relevant factors), Evolution of Slopes, Erosion Surfaces around the Atlantic, Coastal Sedimentation, Periglacial Phenomena, Karst Phenomena, Arid Zones, the Library Classification of Geographical Books and Maps, An Inventory of World Land Use (a record of work known to be in progress in different countries) and The Teaching of Geography in Schools (a factual survey). Published reports, printed or mimeographed, on all these subjects were presented; an interim note was received from the Commission for the Bibliography of Ancient Maps. A Special Committee on Conversion Tables presented a report recommending what tables should be prepared and published. Some of the reports have been published as special parts of scientific journals; of most a small number is retained for distribution by the secretariat. An immense amount of valuable work is in progress and, despite extremely limited funds, the General Assembly agreed at its final session to the reappointment of all these commissions. In addition, the Executive Committee has set up two official commissions: one on the Mapping of Population, and the other on the Humid Tropics, to collaborate with other organizations working in these fields. Two new commissions were also approved: on National Atlases and on Applied Geomorphology.

The arrangements for the conference were excellent. The Brazilian Government made generous financial provisions which enabled a number of distinguished foreign delegates to be offered free air passages. The Navy allowed the meetings to be held, and some two hundred delegates to live, in the well-equipped Escola Naval, delightfully situated in Rio harbour on an island, now almost linked with the heart of the city by the reclaimed land on which the City airport is situated. Many nations joined in providing a magnificent map exhibition housed in the new Ministry of Education building, which also provided an auditorium equipped with simultaneous translation facilities for plenary sessions. In another building was a large selection of Brazilian maps.

The field trips arranged before and after the Congress enabled a large number of delegates to appreciate some of the problems of a vast and difficult country larger than the United States. Travelling by motor-bus over the winding mountainous dirt roads made the reason why 40 per cent of travel is by air obvious: there were times during each day when delegates saw more than one plane a minute handled by the Rio City airport. The extreme contrast between such great skyscraper cities as Belo Horizonte—their very names scarcely known to foreigners—and the vast uninhabited scrub-lands and forests impressed itself on all, while the two three-million cities of Rio and São Paulo left the impression of a growth too rapid for local administration to catch up. Everywhere the delegates met the lavish hospitality and boundless enthusiasm of the Brazilians; but standing above all was the organizing genius of Prof. Hilgard O'Reilly Sternberg and his faithful band of volunteer helpers.

At the final session of the General Assembly the presidency of the Union was handed over to Dr. Hans W:son Ahlmann, of Sweden, distinguished glaciologist, diplomat and don, and the joint invitation of the five Nordic countries of Norway, Sweden, Denmark, Finland and Iceland for the Congress of 1960 was accepted. For the past seven years the secretariat of the Union has been in the able charge of Dr. G. H. T. Kimble as secretary-treasurer: it is now to be transferred to the University of Zurich under Prof. Hans Boesch. The new Executive comprises the President, Secretary-Treasurer and Prof. Sternberg as first Vice-President, together with six Vice-Presidents—Profs. Hassan Awad (Egypt), Chauncy Harris (United States), Max Sorre (France), L. Dudley Stamp (United Kingdom), Fumio Tada (Japan), and Carl Troll (Germany).

L. Dudley Stamp

SCIENCE AND STRATEGY

THE modern Totalitarian Government considers itself above all moral criticism, and pursues its aims by murder by the million, routine employment of torture, the use of deliberate lies, the perversion of justice and, above all, by treating formal agreements as stopgaps to be broken whenever any least advantage is to be gained. Into this world, where good faith has almost vanished from international relationships, there has arrived the control of nuclear energy, which at the same time holds out great hopes for the improvement of man's estate and permits the construction of weapons which stand in a more extreme ratio to those of the Second World War than the latter do to the weapons of the Stone Age.

The authors of the papers in a discussion published in the *Bulletin of Atomic Scientists* for May, while repeating again and again the urgency of a genuine peace, consider the functions of the Armed Services in a world where no such agreement has been reached. It is generally agreed that the H-bomb is a great deterrent; but the first contributor, Sir John Slessor, tries to see just exactly what it will deter. He concludes that global war in the 1914 or 1939 style is finished, since the object of

governments is to win a war, and the new weapons imply such appalling destruction that no war can be won. But he points out that any ban on nuclear weapons alone would "obviously suit the Communists to engage in a war in which their enormous superiority in manpower and conventional armaments could hardly fail to be decisive". For the Western Powers to refuse ever to use the bomb first would ensure their defeat; any uncertainty about its use might lead to another "drift into war". He then puts forward some very interesting arguments that the function of conventional armaments in this situation is as a "trip-wire" to ensure that any future aggression cannot gain its ends without having to face full-scale nuclear war and that, since no future global war can possibly last long, economies must be looked for in those applications required only for long-term hostilities.

The second author, Dr. R. L. Meier, sets out a series of propositions which he considers valid where "there are no important constraints upon how the major powers may act in the short run". The most important and most controversial are No. III, in which he argues for a sharp distinction between conventional weapons and nuclear weapons (Sir John Slessor separates "tactical" nuclear weapons from the H-bomb), and No. VI, that when superweapons have reached a certain level "it appears to be no longer possible to negotiate disarmament at the nuclear level" because "any nation which does not act in good faith would be able to dictate terms to any part of the world, or annihilate it" since "the margin of error in detection and accounting is still enough to dominate". Back to good faith once more.

The third author, Mr. Hanson W. Baldwin, starts with an illuminating and balanced discussion of the new methods for delivering nuclear explosives, and points out that, while the power of the attack has so enormously increased the power of defence, interception has considerably decreased. He recommends that "we must be capable of fighting all-out nuclear war, a limited nuclear war, a major non-nuclear war, small scale brush-wars". This counsel of despair may perhaps be practicable for the United States with its immense resources; it could scarcely be so for Great Britain.

The fourth author, Mr. C. W. Sherwin, emphasizes a further point. That old-fashioned principle of war was to seek out and neutralize the armed forces of the enemy. But in a modern future war these armed forces will be small, light, mobile machines, which can be fairly easily protected against blast, while cities are large, immobile and from their construction very sensitive to blast. In other words, success is probably much easier by attacking civilian populations. This was once forbidden by a Geneva Convention; but such conventions again imply good faith. Mr. Sherwin proceeds by outlining a set of rules for nuclear strategy in a deterrent war; even supposing these rules to be correct it is most unlikely that they could be followed in the mass hysteria of an atomic war. He concludes by hoping that, while the Mark I solution of peace-through-deterrence is perhaps not the ultimate means of preventing major war, it may give time for a final solution. Dr. Warren Amster concludes the discussion in a short article which emphasizes the points made by the previous authors.

This discussion is of the utmost interest, and can scarcely be summarized in so short a review. The discussion is being continued. E. C. BAUGHAN

RESEARCH COUNCIL OF ALBERTA

REPORT FOR 1955

THE thirty-sixth annual report of the Research Council of Alberta*, covering 1955, refers to increased emphasis of basic geological research and survey in view of its importance to much of the Province's resources. Besides the oil-sand area project, clay research, glacial geological studies and micropalæontological research carried over from 1954, further work undertaken included a ground-water survey of the Province, stratigraphical studies of the southern foothills, and a laboratory study on the chemical variation between marine and non-marine sediments. The Council's soil surveyors were again engaged principally in the Peace River district of Alberta; but the report refers also to other projects of the Alberta Soil Survey conducted mainly by Federal Survey staff, such as the field-work on the Edmonton map-sheet and irrigation research on solonetzic soils at Youngstown, in co-operation with the University of Alberta Department of Soil Science, the Canada Experimental Farms Service and the Provincial Department of Agriculture.

Encouraging progress has been made in the re-orientated coal research programme. Investigations of the physical behaviour of coal in an ultrasonic field demonstrated that the 'true' density of coal appears to remain substantially unaffected, but that the surface area of the coal tends to increase with the frequency of vibration and time of exposure; preliminary carbonization tests have indicated that the presence of traces of nitric oxide in the retort can induce significant modifications in the nature of the tar. A combination of infra-red studies and elementary analysis has indicated the relation between humic acid and coals of various ranks, and studies of the oxidation of phenols to humic acid have shown that oxidative polymerization of aromatic substances can yield naphthenic structures known to occur in coal and petroleum. Polarographic studies indicate that humic acids from hydroquinone and low-rank coal have less condensed structures than humic acids from material of higher rank. The presence of a cracking catalyst such as alumina-silicate in carbonization about 600° C. appeared to affect the primary decomposition of the coal as well as the secondary decomposition of the primary tar.

The work of the Applied Research Laboratory was confined to attempts to surface-seal Albertan sub-bituminous coals against loss of water so as to prevent or reduce disintegration during storage. Some success was achieved with emulsions of wax or bitumen, and substantial progress was also made in a study of the grindability of coal.

Petroleum research has included studies of the kinetics of thermal degradation or maturation for the removal of vanadium or nickel from McMurray oil; the work indicates that geological time has been too short to account for the observed maturation of crude oils in Alberta at the temperatures usually regarded as reasonable during geological time, and suggests that considerable importance must be attached to catalysis in the formation of crude oil. A survey has been undertaken of the carcinogenicity of crude oils of Western Canada; detailed investigations of the sulphur content of heavy oils using

* Research Council of Alberta. Thirty-sixth Annual Report, 1955. (Report No. 73.) Pp. 52. (Edmonton: Research Council of Alberta, 1956.)

chromatography on the distillate fraction showed that extraction methods for removing sulphur from the oil-sands oil are unsatisfactory, and studies are being made of desulphurization by catalytic decomposition or oxidation.

Work on natural gas and its utilization was limited to three projects: the partial oxidation of *n*-butane; the production of carbon black; and the high-temperature pyrolysis of butane. Results in the first project indicate that the reaction is essentially that of the 'cold flame', characterized by a pronounced induction period, sharp reaction peak and self-quenching termination. Use of the permeable tube technique has permitted continuous production of carbon black from natural gas for up to four hours; but extensive semi-works tests are required before any economic evaluation of the process can be made. Preliminary results indicate higher partial pressures in the pyrolysis of butane favour formation of ethylene and lower pressures that of acetylene. Winter field trials of the injection of lignosol and lignosol–chromate mixtures to prevent frost-heaving in soils showed that the highly mechanized procedure was less efficient than anticipated and that the designed proportions of lignosol and chromate were not set up in the field as successfully as in the laboratory; a study of the electrosmosis of soils showed that addition of lignosol enabled the solution to move through coarse sands in which the process was ineffective in its absence.

The paucity of the cyclic animal populations continued throughout central and northern Alberta; but a careful census showed increases in selected locations, especially in the south-east of the Province. Measurements of solar ultra-violet radiation were continued. Work on the hatchability of turkey eggs demonstrated that the use of upstanding males in the breeding pens increased fertility compared with eggs from pens in which front-heavy males were used.

Some attention has been given by an *ad hoc* committee to the prevention of hail damage.

RELATIVITY AND SPACE TRAVEL

AFTER the publication in *Nature* of April 28 of communications on this subject by Prof. H. Dingle and Prof. W. H. McCrea, a number of letters were received by the Editors, some of them supporting Prof. Dingle's views and some Prof. McCrea's. Many were mathematical in character, whereas others developed the argument in general terms. It would have been impossible for reasons of space alone to print these letters in full; it seemed to the Editors, therefore, that the best course was to collect the correspondence and to submit a copy of each letter to Prof. Dingle and to Prof. McCrea, who were then invited to prepare their concluding statements in the light of the letters received. This has been done, and the two statements are published below.

THE outstanding fact confirmed by this correspondence (in which I include letters received privately) is profoundly disquieting. In various ways we now actually deal with velocities at which the abnormal relativity phenomena become important, and in matters the gravity of which can scarcely be exaggerated and in which we must act on calculation alone, we are at the mercy of physicists, many of whom can believe that what can be thought away can have effects which cannot.

For obvious reasons, I reply only to correspondents who agree in (and only in) thinking me wrong. They comprise two classes: (*a*) those who hold that the accelerations are irrelevant and I have misread 'special' relativity; (*b*) those who regard the accelerations as important. (McCrea so regards them, but bewilderingly uses them only as a talisman to fecundate the otherwise sterile 'Lorentz contraction' during the *uniform* motion.)

It is difficult to understand the existence of class (*a*), since without the accelerations M and R are indistinguishable. A number 'refute' me by the phenomenon of mesons, the half-life and velocity of which imply that they have suffered a 'time dilatation'. I am astonished that this is thought relevant. The argument seems to be this: "Dingle says that the relativity anomalies are only imaginary: this one is observed: hence Dingle is wrong". What I say is not that these anomalies are "only imaginary", but that they occur only when at least one of the times involved refers to an absent clock and so must be determined by a conventional definition. This is so in the meson case, where effectively the starting time (conventional) is compared with the arrival time (observed); the 'time dilatation' must therefore be expected. In the space traveller problem, however, the clocks are directly compared; convention is eliminated and the anomalies disappear.

In reply to requests, I reluctantly indicate McCrea's error. He writes: "At the event $[E_1]$ of M's completing the part of his outward journey performed with speed V, observer R plots M as at a distance X. . . . Owing to the Lorentz contraction, M at the same event plots R as at distance αX. . . . It does not matter which observer regards himself as at rest". But M observes *another* event, E_2, at which R's uniform travel ends, and McCrea later confirms that it is at E_2 that R's distance is αX. Hence he connects R's estimate for one pair of events (E_0 and E_1, where E_0 is the event of R and M beginning their separation with velocity V) with M's for another (E_0 and E_2) by the "Lorentz contraction", which is clearly wrong. But I repeat that the error of the conclusion should be obvious without this.

A complete solution of the space traveller problem on the basis of special relativity, showing how the anomalies cancel out, will be published by the Physical Society.

Now for the accelerations. General relativity asserts that *all* motion is relative (that is, all co-ordinate systems are equivalent). It has convincingly formulated this principle only for gravitational motions; but, if it is true, no acceleration affects a clock. Some think this inconsistent with the displacement of spectrum lines in a gravitational field, but that is caused by the *field*, not acceleration. If the stellar atoms are stationary it is still required.

We do not know what effect other causes of acceleration may have. Hence, since our traveller will certainly not be ejected by gravitation, we cannot state the effect, if any, of the means employed. But, by hypothesis, the process is too brief for appreciable slowing down.

The only escape is by supposing, as some do, that the initial acceleration causes a change of rate which persists when the motion becomes uniform. This is arbitrary, and to justify McCrea's formula the change would astonishingly have to be exactly equal to the

Lorentz value for the final uniform motion for all methods and degrees of acceleration. Also, it would stultify modern astronomy, because every supposed Doppler effect might be actually the legacy of earlier unknown accelerations.

The only attempted defence of this is by an enormous generalization. The paths of the Earth and traveller are considered as world-lines in some specifiable space-time, and it is pointed out that such a space-time permits alternative world-lines with very different proper times. No doubt; but those who reason thus omit to specify the space-time and to show that the paths in our problem differ by the assigned amount, and I am certain that they cannot. The invocation of space-time is quite unnecessary, but if done it must be done thoroughly.

To sum up: if accelerations are ignored, symmetry shows that the clocks cannot differ on re-union. If, however, accelerations determine the issue, then either the $2\frac{1}{2}$ years (if gained at all) is gained during them or they affect the later rate of the uniformly moving clock. The former is impossible; the accelerations may be far too brief. Hence the rate of a uniformly moving clock, for no known reason, depends on previous accelerations, and all astronomical deductions from supposed Doppler effects are vitiated.

A final word on the moral of the whole thing. I have been told by some who omit to give reasons for their views, that although I may not understand the matter, mathematicians do so very well and agree that I am wrong. I am not, and have no wish to be, a mathematician in the restricted sense; by nature and taste I choose the world of experience, and I trust reason rather than personal authority however graciously exercised. Nevertheless, "when the wind is southerly" I know a group from a tensor, and in science it is better to be the master of a little mathematics than the slave of much. But what is needed here is not mathematics but a faculty for refusing to be bemused by mathematicians. Unfortunately, this seems to be a rare faculty. Still more unfortunately, it is held in such low esteem in Great Britain that we have the unenvied distinction of being the only major country in the world which has not thought it worth while to join the International Union for the History and Philosophy of Science. It is no accident that we rank high as builders of massive mathematical edifices on rotten foundations. I hope that this small but dangerous one has at least received a shaking.

HERBERT DINGLE

PROF. DINGLE'S statements about the work of others are irresponsible. He says I connect "*R*'s estimate for one pair of events with *M*'s for another by the 'Lorentz contraction', which is clearly wrong". The procedure is clearly right, since it is precisely the way in which the Lorentz contraction arises. But the pairs of events named by Dingle are not simultaneous in the reckonings of the respective observers and so are not pairs that can be directly connected by the Lorentz contraction; reference to my work will make it at once obvious that I did not apply the procedure directly to these pairs. On the other hand, if Dingle means merely that I used the contraction in the course of connecting these events, that is all right. Either way, he has detected no error.

Dingle's treatment[1] of Einstein's "most regrettable error" follows the same pattern. (I had not seen this passage of Dingle's before writing my previous reply.) Again he categorically asserts the reverse of the truth. He says Einstein is wrong because he deals with the motion of a clock that is "continuously accelerated and with such motions the special theory of relativity is powerless to deal". But the truth is that (special) relativistic kinematics, mechanics and electrodynamics deal throughout with motions that are in general continuously accelerated.

As to the result itself that is under discussion, Dingle appears still to assert that there is symmetry between the space-traveller and the stay-at-home. But, were the reversal of the space-traveller's motion sufficiently violent, the space-traveller, not Prof. Dingle, would be killed. Dingle would not be symmetrical with a traveller who turns into a corpse. Since there is obviously not symmetry and, according to relativity theory, there is not universal time, there is no *a priori* reason for the journey to have the same duration by the clocks of the two observers. In general, the journey does not take the same time by the two clocks. This is the immediate consequence of relativity theory that Einstein derived correctly fifty years ago.

The main points mentioned by correspondents concern (*a*) inertial frames, (*b*) accelerations and the behaviour of clocks, (*c*) the resolution of the 'clock paradox'. Other matters raised seem to be outside the scope of the discussion.

(*a*) In classical theory, an inertial frame is one in which Newton's laws of motion hold good; the existence of such a frame is postulated and it is proved that any frame in uniform relative motion, and no other, is an inertial frame. The situation in special relativity is strictly analogous. Some correspondents give the exact quotation from Einstein[2] that Dingle failed to discover. There is not symmetry between *R*, *M* because *R* remains at rest relative to an inertial frame and *M* does not. Dingle implies that *M* cannot identify the event of his ceasing to be in a particular inertial frame. The simplest way of settling the whole argument would be to give Dingle the opportunity to see if *he* would identify a swift change from one inertial frame to another—allowing him thus to "choose the world of experience".

We know how to use inertial frames. We know also, as correspondents remark, that whether or not a particular frame is inertial is determined by its relationship to the universe in the large. But we probably do not adequately understand the physics of this relationship[3]. Dingle could have directed attention to a real problem here.

(*b*) In the example previously considered, the durations of the accelerations could be made arbitrarily short compared with the other times involved. But this served only to simplify the calculation. In the general case there is no mystery about accelerations. If an observer is accelerated in any given possible way, we can integrate the interval along his world-line and so get the proper-time as shown by his ideal standard clock.

Some correspondents think the simple example may be deficient since, they say, *M* could not separate from *R* without producing a reaction upon *R*. This is false because the case would be realized by *M* using rocket-propulsion having no effect on *R*.

Questions are raised about 'biological' time. During acceleration relative to an inertial frame, biological processes need not be synchronized with a standard

clock accompanying the system. This is obvious because, as already said, a violent enough acceleration may have fatal consequences. Beyond showing the absurdity of Dingle's views on what events can and cannot be identified, this is not relevant to the discussion. It is on the same footing as the fact that a living organism is not a rigid body. In any case, we could choose accelerations such that, for any given organism, the difference between 'biological' time and clock-time is made proportionately arbitrarily small. That is, the sort of case mentioned by Sir George Thomson could be realized, as regards ageing of observers, as closely as we please.

(*c*) All the foregoing has been known since Einstein's paper of 1905. The communication[4] of mine that has drawn Dingle's attack was a demonstration that these well-known conclusions do not produce a paradox. At least one correspondent reproduces my calculations in full and one detail has to be mentioned. If M treats himself as at rest, I had pointed out that his plot of R's journey shows R moving out to distance αX at speed V, rushing out to distance X and back to distance αX in negligible time, and finally completing his return at speed V; total time $2\alpha T$, where $\alpha = (1 - V^2/c^2)^{1/2}$. Throughout all but the negligible portion of this time, M is in one or other of two inertial frames and plots R as having a uniform speed V; so, by the time dilatation, the parts of R's career so plotted have duration $2\alpha^2 T$ by R's clock. However, between these parts there is also the part that M plots as taking negligible time but that by R's clock makes up the total duration to $2T$. By overlooking this last-mentioned part, other correspondents encountered a difficulty.

I express the results in terms of what the observers would *plot* after making all their observations and allowing for times of light-travel, each regarding himself as at rest. Alternatively, I could have expressed them in terms of what each observer would *see* at each instant in his career. Some correspondents have trouble through confusing these two methods. However, the only thing that matters is that the observers get different descriptions of each other's behaviour, and consequently there is no paradox in their assigning different durations to the journey. The curious details of M's plot of R's behaviour when M treats himself as at rest are not really important, because M will discover that it is much simpler not to treat himself as at rest.

In my previous reply I gave arguments concerning geodesics that are valid in special and in general relativity. In my present reply, I refer only to special relativity. This is correct because, when gravitational effects are irrelevant, the theories are identical.

W. H. McCrea

Royal Holloway College,
Englefield Green,
Surrey.

[1] Dingle, H., *Nature*, 177, 782 (1956).
[2] Einstein, A., *Ann. d. Physik.*, 17, 891 (1905); cf. Part I, §1, first sentence.
[3] Sciama, D. W., *Mon. Not. Roy. Astro. Soc.*, 113, 34 (1953).
[4] McCrea, W. H., *Nature*, 167, 680 (1951).

THE STOICHIOMETRIC RELATIONSHIP BETWEEN AMINO-ACID AND NUCLEOTIDE RESIDUES IN A RIBONUCLEOPROTEIN

By Prof. ERWIN CHARGAFF, Dr. DAVID ELSON* and Dr. HAROLD T. SHIGEURA

Cell Chemistry Laboratory, Department of Biochemistry, College of Physicians and Surgeons, Columbia University, New York

THE statement that there exists some evidence of a relationship between pentose nucleic acid and the synthesis of proteins does not demand the acceptance of one or the other of the numerous 'template' mechanisms that have been put forward[1]. In their usual form, these proposals envisage the condensation of amino-acids along a polynucleotide chain or the simultaneous and interdependent polymerization of nucleotides and amino-acids to form an intermediary nucleoprotein complex from which, for the protein itself to emerge, the nucleic acid would have to be removed, either by dissociation or by degradation. Should an enzyme have been formed in this manner, it would presumably not function before being released from its association with the nucleic acid. The literature contains few systematic studies of the properties of nucleoproteins; but occasional reports of an enhanced enzymic activity of cell preparations or cellular fractions after treatment with ribonuclease[2–4] tend to support this concept. If pentose nucleoproteins are to be regarded as an intermediate stage in protein synthesis, their study assumes added interest.

We wish to present observations made in the initial phase of a study of pentose nucleoproteins from rat liver. Our immediate objectives were: (*a*) the development of a relatively rapid and simple procedure for the purification of pentose nucleoproteins; and (*b*) the examination of the stoichiometric relationship between the nucleotides and the amino-acids present in the conjugated protein. As regards the latter aim, we have pointed out recently[5] that a 'template' arrangement could be expected to impose rather definite restrictions on the relative quantities of the two types of monomer.

The microsome fraction of rat liver[6] served as the source of pentose nucleoprotein. These cytoplasmic structures contain, or are associated with, small granules which appear to be pentose nucleoproteins. (For literature, compare several recent articles[7–10].) For the release of these granules from the microsomes, structures rich in lipids, sodium deoxycholate has often been employed[8,10]—an agent that had been shown previously to produce the cleavage of other lipid-nucleoprotein complexes[11]. This effect is no doubt related to the surface activity and, even more, to the strong complexing ability of this bile acid. The treatment with sodium deoxycholate causes the microsomes to disintegrate, but leaves the small dense granules apparently intact and largely recoverable by high-speed centrifugation. The pellet so obtained

* Present address: Weizmann Institute of Science, Rehovot, Israel.

contains a large part of the pentose nucleic acid, but little or none of the lipid, of the microsomes and a proportion of protein that decreases in measure with the rise in the concentration of deoxycholate.

We have found that a limiting value for the molar ratio of nucleotide to amino-acid is reached at a concentration of approximately 0·5 per cent of a neutral solution of sodium deoxycholate. Moreover, this ratio remains unchanged when the nucleoprotein preparations are subjected afterwards to successive precipitation with ammonium sulphate and with barium and calcium ions.

The suspension of microsomes in 0·9 *M* sucrose solution (isolated from the livers of male Sherman rats weighing about 250 gm. and unfed overnight) was brought to the desired deoxycholate concentration by the addition of a freshly prepared 5 per cent solution of sodium deoxycholate (*p*H 7·3–7·5). The sedimentable material, which in no case comprised more than about one-half of the microsomal pentose nucleic acid, was collected by centrifugation at 105,000 × *g* for two hours. An attempt was made to fractionate such sediments, prepared in 1·6 per cent deoxycholate, by subjecting them to consecutive precipitation with ammonium sulphate, calcium acetate and barium acetate. The latter two reagents may be considered less likely to precipitate protein that did not form an integral part of the nucleoprotein. Data on the composition of the nucleoprotein insoluble at different concentrations of sodium deoxycholate are summarized in Table 1, details of two reprecipitation experiments in Table 2.

For analysis, protein and pentose nucleic acid were separated in the following manner. The material was precipitated or washed with cold 7 per cent trichloroacetic acid, extracted with alcohol-ether, and kept overnight at 30° and *p*H 13–13·5, in order to hydrolyse the nucleic acid to mononucleotides. During this treatment one protein fraction precipitates (Fraction I). For purposes of analysis, this material was not examined separately. The mixture was centrifuged briefly and chilled, and the supernatant fluid acidified to *p*H 5–6 and left in the cold for 15–20 hr., when a second crop of protein (Fraction II) precipitated which was collected by centrifugation. The final supernatant solution was considered as the nucleic acid fraction and the combined precipitates (I and II) were taken as the protein fraction. The effectiveness of this separation procedure was roughly checked by comparing the ultra-violet light absorption of the nucleotide solution at 280 and 260 mμ. The relative values regularly found were those expected of a hydrolysate of pure ribonucleic acid from the cytoplasm of rat liver[13] and gave no sign of contamination by aromatic amino-acids. Direct amino-acid analyses also showed that less than 1 per cent of the total amino-acids was carried into the nucleic acid fraction.

Table 1. Composition of Rat Liver Ribonucleoprotein prepared at Different Sodium Deoxycholate Concentrations

Experiment No.*	Final concentration of sodium deoxycholate, per cent	Molar ratio of nucleotide to amino-acid
1	0·4	0·32
2	0·5	0·44
3	0·8	0·53
4	1·2	0·52
5	1·6	0·52
6	1·6	0·44
7	2·0	0·47

* In Exps. 1, 3 to 5, and 7 a Riedel-de Haen preparation of sodium deoxycholate was used; in Exps. 2 and 6 a preparation furnished by A. Maschmeijer, Jr. Inc. When 0·2 per cent sodium deoxycholate was employed, about 90 per cent of the microsomal nucleic acid was recovered in the pellet; with the higher deoxycholate concentrations used here the recovery varied between 40 and 50 per cent.

Table 2. Composition of Ribonucleoprotein after Treatment with Different Reagents

Experiment No.	Precipitating agent*	Recovery of ultra-violet absorption, as per cent of preceding precipitate	Molar ratio of nucleotide to amino-acid
1	3·2 *M* ammonium sulphate[1]	89	0·50
	0·08 *M* calcium acetate[2]	96	0·49
	3·2 *M* ammonium sulphate[1]	83	0·52
2	3·2 *M* ammonium sulphate[1]	80	0·44
	0·08 *M* calcium acetate[2]	82	0·50
	3·2 *M* ammonium sulphate[1]	90	0·61
	0·08 *M* barium acetate[3]	38	0·56

* The precipitating agent (dissolved in 0·7 to 0·9 *M* sucrose solution to yield the final concentrations listed in the text) was added to the suspension of the preparation in 0·9 *M* sucrose solution and the precipitate collected by centrifugation at 3,000–4,000 × *g*. It was dispersed in the appropriate medium (see following footnotes); the mixture was cleared by low-speed centrifugation; a portion was withdrawn for analysis, and the process was repeated with the next precipitating agent, in the order indicated for each experiment.

[1] 60 per cent saturated at 0°. The precipitate was redispersed in 0·9 *M* sucrose; the solution was subjected to dialysis if barium acetate was to be used next.

[2] The precipitate was redispersed in 0·8 *M* sucrose containing 0·01 *M* sodium oxalate.

[3] The precipitate was redispersed in 0·8 *M* sucrose containing 0·01 *M* sodium sulphate.

The molar nucleotide content of the solution was estimated from the difference of the extinction values at 260 and at 280 mμ at *p*H 7·0. A figure of 1·0 was taken as equivalent to 0·110 micromole of nucleotide per ml.; a value based on observed data and agreeing with the calculated absorption of a mixture of nucleotides in the proportions characteristic of rat liver cytoplasm[13]. The values so obtained were very close to those derived from phosphorus determinations and quantitative paper chromatography[13].

The protein fraction was hydrolysed in 6 *N* hydrochloric acid at 110° for 24 hr. and the residue, resulting from the evaporation of the hydrolysis mixture *in vacuo*, was dissolved in water. The molar amino-acid content was determined colorimetrically by means of ninhydrin[14], with known quantities of alanine or glycine as an internal standard. The values agreed closely with those obtained with external standards and, independently, with the ninhydrin/carbon dioxide technique[15,16].

Some of the properties of the nucleoprotein may be of interest. The two protein fractions mentioned before, namely, Fraction I, insoluble at *p*H 13, and Fraction II, soluble at this *p*H, were present in almost equal proportions. In three preparations, the following figures, as per cent of moles of total amino-acid present in the nucleoprotein, were found for Fraction I: 54, 56, 56. When the ribonucleoprotein was treated with papain[17], it was found that about one-half of the protein moiety was digested. With several specimens, the proportion of protein liberated as amino-acids after a treatment of 4–5 hr. varied from 42 to 57 per cent of the total; no further digestion took place even after 24 hr. The ease of detachment of the nucleic acid from the protein by heat[18] was also studied. When a 0·2 per cent suspension of the nucleoprotein in 0·13 *M* sodium

chloride solution was kept near 100° for two minutes almost the entire protein (92 per cent) was precipitated, whereas 60 per cent of the nucleic acid remained in the supernatant fluid.

It will be seen in Table 1 that the molar ratio of nucleotide to amino-acid in the nucleoprotein preparations apparently rises to a limiting value of about 0·5 and remains constant over a fairly wide range of sodium deoxycholate concentration. What is also noteworthy is that this ratio continues essentially unchanged throughout a series of additional mild precipitation procedures (Table 2). It will be understood that we are here concerned only with the number, not the nature, of the nucleotide and amino-acid residues; but it should be mentioned that in a few specimens that were more fully analysed no deviation from the nucleotide proportions previously reported[12] was found.

We conclude that the nucleoprotein preparations under study contained about two amino-acid residues for one nucleotide residue. That this relationship was not changed by successive treatment with different precipitating or solubilizing agents may indicate that virtually all the protein was linked to nucleic acid, though not necessarily all in the same manner. The specific structural significance of this finding must, however, remain obscure until the modes of linkage between protein and nucleic acid and the meaning of the two protein fractions that are distinguishable in the nucleoprotein are better understood. The stoichiometric relationship discussed here is not contradicted by previous analytical findings in the literature[7,8,10,13]; it is of a not unreasonable order of magnitude for a 'template' complex; but it fails to lead to a model as capable of explaining the regularities in the composition of pentose nucleic acids, namely, the equality of the number of 6-amino-nucleotides (adenylic and cytidylic acids) and 6-keto-nucleotides (guanylic and uridylic acids)[5,20], as is the hypothetical arrangement (a polypeptide chain linked to two polynucleotide chains) suggested by us recently[5].

We are very grateful to Mr. H. M. Schulman for technical assistance, to Dr. E. L. Smith for a specimen of the crystalline mercury complex of papain, and to Drs. G. E. Palade and P. Siekevitz for acquainting us with some of their findings before publication. This work, which is being continued, was supported by research grants from the U.S. Public Health Service, the National Science Foundation, and the Rockefeller Foundation.

[1] Brachet, J., in "The Nucleic Acids" (edited by Chargaff and Davidson), **2**, 475 (New York, 1955).
[2] Lundblad, G., and Hultin, E., *Exp. Cell. Res.*, **6**, 249 (1954).
[3] Roth, J. S., *Nature*, **174**, 129 (1954).
[4] Allard, C., De Lamirande, G., and Cantero, A., *Biochim. et Biophys. Acta*, **18**, 578 (1955).
[5] Elson, D., and Chargaff, E., *Biochim. et Biophys. Acta*, **17**, 367 (1955).
[6] Hogeboom, G. H., and Schneider, W. C., in "The Nucleic Acids" (edited by Chargaff and Davidson), **2**, 199 (New York, 1955).
[7] Petermann, M. L., Hamilton, M. G., and Mizen, N. A., *Cancer Res.*, **14**, 360 (1954).
[8] Littlefield, J. W., Keller, E. B., Gross, J., and Zamecnik, P. C., *J. Biol. Chem.*, **217**, 111 (1955).
[9] Kuff, E. L., Hogeboom, G. H., and Dalton, A. J., *J. Biophys. and Biochem. Cytol.*, **2**, 33 (1956).
[10] Palade, G. E., and Siekevitz, P., *J. Biophys. and Biochem. Cytol.*, **2**, 171 (1956).
[11] Chargaff, E., *J. Biol. Chem.*, **173**, 253 (1948).
[12] Elson, D., Trent, L. W., and Chargaff, E., *Biochim. et Biophys. Acta*, **17**, 362 (1955).
[13] Magasanik, B., Vischer, E., Doniger, R., Elson, D., and Chargaff, E., *J. Biol. Chem.*, **186**, 37 (1950).
[14] Troll, W., and Cannan, R. K., *J. Biol. Chem.*, **200**, 803 (1953).
[15] Van Slyke, D. D., Dillon, R. T., MacFadyen, D. A., and Hamilton, P., *J. Biol. Chem.*, **141**, 627 (1941).
[16] Hamilton, P. B., and Van Slyke, D. D., *J. Biol. Chem.*, **150**, 231 (1943).
[17] Kimmel, J. R., and Smith, E. L., *J. Biol. Chem.*, **207**, 515 (1954).
[18] Cohen, S. S., and Stanley, W. M., *J. Biol. Chem.*, **144**, 589 (1942).
[19] Parsons, C. H., *Arch. Biochem. Biophys.*, **47**, 76 (1953).
[20] Elson, D., and Chargaff, E., *Nature*, **173**, 1037 (1954).

MECHANISM OF ENTRY OF 5-BROMOURACIL AND ORTHOPHOSPHATE INTO DEOXYRIBONUCLEIC ACID OF *E. COLI*

By Drs. T. D. PRICE, P. B. HUDSON, H. H. HINDS, R. A. DARMSTADT and S. ZAMENHOF

Departments of Biochemistry and Urology, and the Institute of Cancer Research, Columbia University, College of Physicians and Surgeons, and Francis Delafield Hospital, New York 32

STUDIES seeking information on *in vivo* roles of nucleotides in nucleic acid biosynthesis[1] have hitherto proved inconclusive, interpretation of the experimental findings being complicated by difficulty in appraisal of contributions of the following phenomena: (1) the rate of penetration of nucleotides *per se* through cell walls may be low compared to the rates of side reactions[2]; (2) the rate of renewal of the phosphorus of intracellular mononucleotides is generally very high compared to the rate of renewal of the phosphorus of nucleic acids[3–6].

Phosphomonoesterase and phosphotransferase enzymes of high activity are doubtless implicated. The phenomena apparently merit special consideration in the design of experiments on this aspect of nucleic acid metabolism. To eliminate the problem posed by the permeability property, we have used mixtures of traceable, diffusible compounds that are potential precursors of the nucleotides, in place of the isotopically labelled nucleotides employed before[1,2]. To avoid complications resulting from superimposable isotope dilutions of labelled precursor atoms by (*a*) pools of endogenous intermediates, and (*b*) rapidly reversible side reactions, it occurred to us that dilution (*a*) can be eliminated in experiments with biological systems that readily accept a physiologically abnormal base, such as 5-bromouracil, in lieu of a base normally present in their nucleic acid.

Zamenhof and Griboff have described a mutant of *E. coli* that normally requires 5-methyluracil (thymine) for synthesis of deoxyribonucleic acid, but is capable of utilizing 5-bromouracil in reversible replacement of

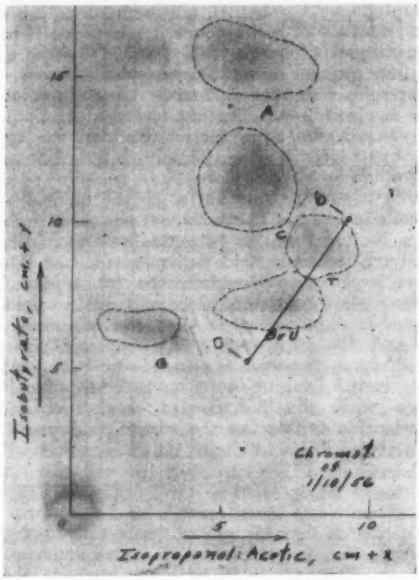


Fig. 1. Radioautograph of a chromatogram containing deoxyribotides of deoxyribonucleic acid from *E. coli* grown from a culture of 5·32–6·46 × 10^{13} cells in a medium with 0·1 mgm./ml. 5-bromouracil and 3 mc. of orthophosphate-^{32}P. *G*, *BrU*, *T*, *C* and *A* identify deposits of deoxyribotides of guanine, 5-bromouracil, thymine, cytosine and adenine, respectively. Measurements shown in Fig. 2 were along line crossing *BrU* and *T*. Photograph taken with radioautograph over labelled centimetre scale

the thymine[5,6]. The main advantage sought by the use of this organism in the present study follows from the possibility of conducting an experiment wherein one of the bases is all newly acquired by the deoxyribonucleic acid. The abnormal base, with the deoxyribose and phosphate to which it becomes attached, can be separated as a unit from enzyme hydrolysates. We reasoned that growth of an originally normal culture from, say, 100 per cent to 120 per cent, in the presence of simultaneously added 5-bromouracil and phosphate-^{32}P, would yield deoxyribonucleic acid with a 5′-isomer of 5-bromouracil 2′-deoxyribotide having specific phosphorus-32 activity markedly dependent upon the source of the phosphorus in this unit of its molecule. On performing the experiment, it was found that the 5′-isomer of 5-bromouridylic acid isolated from the *E. coli* ribonucleic acid had a specific activity comparable to that which would be expected if all its phosphorus is acquired from the medium during the experimental interval.

Bromouracil and orthophosphate-^{32}P were added near the end of the logarithmic stage of growth of strain 1 *E. coli*[5] in a normal thymine-containing medium[6]. In the typical experiment considered here, the cells were then cultured for 17 hr., during which time the cell count increased 21 per cent. They were lysed with 'Duponol'[6]; crude deoxyribonucleic acid was isolated by conventional means, and treated with 0·3 *N* lithium hydroxide[7] to hydrolyse residual ribonucleic acid and phosphoprotein. After a preliminary development by chromatography with an *iso*butyrate solvent (*p*H 3·6) which moves small-molecule contaminants away from the immobile deoxyribonucleic acid[8], it was eluted, and hydrolysed in 60–80 per cent yield to 5′-mononucleotides employing deoxyribonuclease and arsenate-inhibited intestinal phosphatase[9]. To isolate 5-bromouracil deoxyribotide, Dunn and Smith's[10] electrophoretic separation at *p*H 9·0, and Smith and Allen's[8] two-dimensional paper chromatographic separation were used; the latter system separates all the 5′-monodeoxyribotides (Fig. 1). These compounds were identified by their absorption spectra measured on the paper[11]. Specific phosphorus-32 activity of the nucleotides was determined from measurements of radioactivity and light-absorption of identical fractions[12], the quantity of compound in a measured area of neutral Whatman 3 *MM* paper being computed from a light-diffusion equation that corrects for decrease in the optical depth of a papergram with increase in the concentration of absorber[11,12]. A detailed report on the derivation and use of the practical form of the equation[13] is in preparation. Radiochemical purity was evaluated by constancy of the specific activity at successive areas along lanes of transit[12]. In the illustrative case shown in Figs. 1 and 2, however, the measurements were made along a diagonal line traversing two important deposits. The ordinate values of points in the top graph of Fig. 2 are proportional to specific activity, which may be computed as follows:

$$\text{Specific activity} = R/C = RL\varepsilon/\Delta E \qquad (1)$$

where R is phosphorus-32 radioactivity (counts per min. per sq. cm.), C is concentration (millimoles per sq. cm.), L is optical depth (a dimensionless relative-length variable)[11,12], ε is the conventional molar

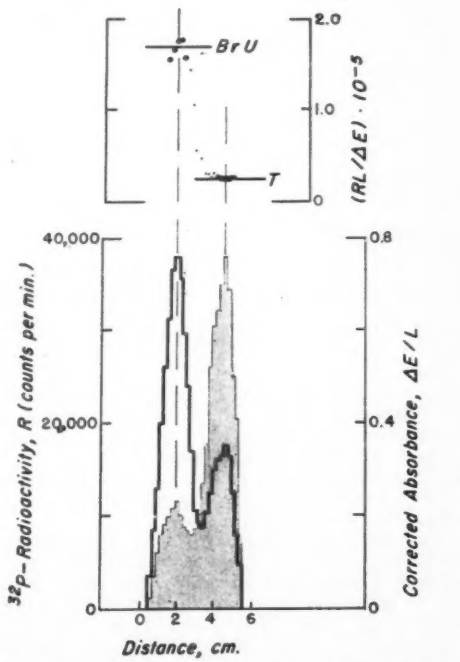


Fig. 2. Open bars: ^{32}P-radioactivity, *R*. Shaded bars: absorbance of deposited material (ΔE) corrected[12] to a constant optical depth equalling the rectilinear thickness of the papergram, $\Delta E/L$. Circles: ^{32}P-radioactivity divided by corrected absorbance, $RL/\Delta E$. Results from measurement of ^{32}P-radioactivity and absorbance of light of 254 mμ at successive 0·15 sq. cm. areas along line (Fig. 1) through centres of deposits of 5-bromouracil deoxyribotide and thymine deoxyribotide

Table 1. Specific Activity of Deoxyribonucleotides of *E. coli* Deoxyribonucleic Acid after 21 per cent and 10^2-fold Increases in Number of Cells

Compound	Specific activity*			
	21 per cent increase		10^2-fold increase†	
	Experimental (*A*)	Relative to 5-BrU (*B*)	Experimental (*C*)	Relative to 5-BrU (*D*)
5-Bromouridylic acid	357 ± 17	100	229 ± 16	100
Thymidylic acid	60 ± 1·2	17	233 ± 12	102
Deoxyribocytidylic acid	104 ± 14	29	214	93
Deoxyriboguanylic acid	130 ± 6·3	37	186	81
Deoxyriboadenylic acid	131 ± 5·1	37	249	109

* Experimental values in columns (*A*) and (*C*) are expressed in counts per minute per millimicromole of nucleotide. Values in (*B*) and (*D*) are relative to 5-bromouridylic acid as 100.

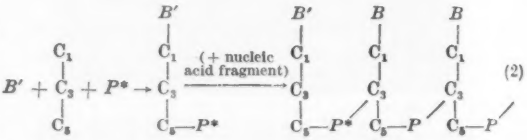
† Theoretically the nucleotides here should be uniformly labelled with phosphorus-32, since virtually all cells were newly formed. Except for the compounds of major interest, 5-bromouridylic acid and thymidylic acid, the values in column (*C*) are results of single measurements. From both theory and results of more critical studies, all values in column (*D*) should be very close to 100.

extinction coefficient (sq. cm. per millemole), and ΔE is absorbance (or optical density) of the measured area with the paper adjacent to the deposit as blank. ε_{254} used for deoxyribotides of 5-bromouracil, thymine, cytosine, guanine and adenine were 4,600, 5,800, 6,000, 13,100 and 13,100, respectively. The specific activity so obtained was multiplied by a factor of 0·447 to correct to a standard phosphorus-32 dosage for the values listed in column *A* of Table 1.

Table 1 shows the results, with those from a control experiment (columns *C* and *D*) where there was a 10^2-fold increase in the number of *E. coli* cells following addition of the bromouracil and orthophosphate-^{32}P at inoculation. After the 21 per cent increase in number of *E. coli*, the specific phosphorus-32 activity of 5-bromouracil deoxyribotide released from the deoxyribonucleic acid as the 5′-isomer is seen to exceed greatly that of any of the other 5′-deoxyribotides. Its isotope concentration at this time was about 50 per cent higher than that of orthophosphate (240 counts/min./millimicromole) isolated from a water extract of the lysed cells. The time curve for specific activity of the 5-bromouracil deoxyribotide of deoxyribonucleic acid is a descending curve, as we would expect if its phosphorus is all newly acquired from labile phosphate of the medium and it enters a deoxyribonucleic acid which has initially no bromouridylic acid. Since the concentration of phosphorus-32 in phosphorus of the labile pool decreases because of continuous dilution with non-radioactive phosphorus that was originally in organic combination with constituents of the cells and the medium used, so also the specific activity of a labile free 5-bromouridylic acid entering the deoxyribonucleic acid must decrease.

The deoxyribonucleic acid of *E. coli* contains the four natural bases in equimolar quantities[14], and the process of replacing thymine by bromouracil is found not to alter this state, providing that the abnormal substituting base is considered as part of the 'thymine'[5,6]. If all the bases enter deoxyribonucleic acid by way of 2′-deoxyribonucleoside-5′-phosphate units, and renewal of phosphorus in these mononucleotides before entry is so rapid that they all quickly have equal specific phosphorus-32 activities, we might expect to find that in the deoxyribonucleic acid the specific phosphorus-32 activity of 'thymidylic acid' (that is, the sum of activities of deoxyribotides of 5-bromouracil and 5-methyluracil in an aliquot of hydrolysate divided by the corresponding number of millimicromoles) should equal the specific phosphorus-32 activity of each of the other nucleotide constituents (column *A*, Table 1). The value found from further data of the typical experiment cited is close, namely, 140 ± 5·3 counts/min./millimicromole. Furthermore, the same practical equality is found to obtain when the increase of *E. coli* cells is 4·4, 35, 121 or 99,900 per cent.

The findings on the 5-bromouracil deoxyribotide of deoxyribonucleic acid demonstrate that there is acquisition of phosphate from the 'labile pool' when 5-bromouracil enters the deoxyribonucleic acid. A reasonable explanation is that the abnormal base (*B′*) and the radioactive phosphate (P*) become affixed to a pentose at its 1′- and 5′-positions, respectively, forming a 5′-nucleotide, which condenses with the 3′-hydroxyl group of another 5′-nucleotide situated at the end of a fragment of a deoxyribonucleic acid chain, thus :



where *B* signifies a naturally occurring base, C signifies carbons at reactive positions of the pentose, and *P* is a normal internucleotide phosphate link.

Equation 2 may well depict essentials of the condensation reactions that take place in assembly of the natural nucleotide units of the nucleic acids. Considering effects mentioned in the opening paragraph, data from earlier studies no longer seem to exclude nucleotides (including potentially important nucleoside-5′-pyrophosphates[15]) as the condensing precursor compounds in nucleic acid biosynthesis. Our data on the natural deoxyribonucleoside-5′-phosphate units isolated from the *E. coli* deoxyribonucleic acid were easily reconciled with the hypothesis that they originally entered it as the same units.

The technical assistance of Miss R. De Giovanni and Mr. K. Rich is gratefully acknowledged. The investigation was supported by grants from the Division of Biology and Medicine of the U.S. Atomic Energy Commission, the U.S. Public Health Service, and the American Cancer Society.

1 Brown, G. B., and Roll, P. M., in "The Nucleic Acids", edited by Chargaff, E., and Davidson, J. N. (Academic Press, New York, 1955).

2 Leibman, K. C., and Heidelberger, C., *J. Biol. Chem.*, **216**, 823 (1955).

3 Sacks, J., *Arch. Biochem.*, **30**, 423 (1951).

4 Daoust, R., and Cantero, A., *Canc. Res. Proc.*, **1**, 2, 10 (1954).

5 Zamenhof, S., and Griboff, G., *Nature*, **174**, 306, 307 (1954).

6 Zamenhof, S., Reiner, B., De Giovanni, R., and Rich, K., *J. Biol. Chem.*, **219**, 165 (1956).

7 Price, T. D., Hudson, P. B., Eisler, L., and Futter, I., *Fed. Proc.*, **13**, 276 (1954).

8 Smith, K. C., and Allen, F. W., *J. Amer. Chem. Soc.*, **75**, 2131 (1953).

9 Klein, W., *Z. Physiol. Chem.*, **218**, 164 (1933).

10 Dunn, D. B., and Smith, J. D., *Nature*, **174**, 305 (1954).

11 Price, T. D., Hudson, P. B., and Ashman, D. F., *Nature*, **175**, 45 (1955).

12 Price, T. D., and Hudson, P. B., *Nucleonics*, **13**, 3, 54 (1955).

13 Price, T. D., *Fed. Proc.*, **14**, 264 (1955).

14 Gandelman, B., Zamenhof, S., and Chargaff, E., *Biochim. et Biophys. Acta*, **9**, 399 (1952).

15 Grunberg-Manago, M., and Ochoa, S., *J. Amer. Chem. Soc.*, **77**, 3165 (1955).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Rotation Period of the Planet Venus as determined by Radio Observations

In previous communications, observations of the planet Venus at a wave-length of 11 metres at the Ohio State University have been reported[1]. Based on these and subsequent observations, it has been possible to deduce a probable value for the rotation period of the planet.

As was mentioned, the Venus signals show marked fluctuations in intensity, and during March 1956 the periods of peak Venus activity appeared to group at an interval tentatively estimated as about eleven days. In subsequent observations this tendency has been re-observed, but with the interval appearing to be more like thirteen days. In Fig. 1 the periods of more intense activity during most of June and July 1956 are plotted as a function of the time (E.S.T.) and day of the month. The manner in which the peak activity periods drift from day to day suggests: (1) that the signals originate at a single localized region or several such regions grouped more to one side of the planet, and (2) that the rotation period of Venus is slightly less than one day, this 13-day interval being the beat-frequency rate between the rotation periods of Venus and the Earth; that is, the two planets return to the same relative angular phase every thirteen days. It is assumed that the source regions are relatively fixed with respect to the surface of the planet.

The slanting lines in Fig. 1 indicate the time a fixed source on the planet would cross the central meridian on a given day for the 13-day repetition interval. This interval provides a satisfactory fit with the observations of Fig. 1 and also with data as far back as March 1956. Actually an interval of 12·75 days fits the observations almost equally well. Neglecting second-order effects, the rotation period is given by $24\ [1 - \{1/(N+1)\}]$ hours, where N is the number of days in the repetition interval. For an interval of thirteen days, the rotation period is 22 hr. 17 min., while for an interval of 12·75 days the rotation period is 22 hr. 15 min.

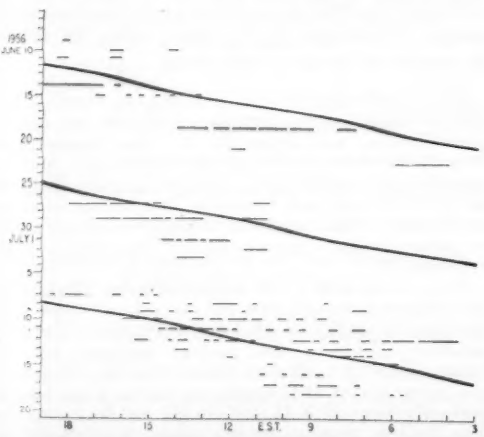


Fig. 1. Periods of peak intensity of 11-m. radio signals from Venus during June and July 1956

For a number of days beginning with July 9, 1956, records were obtained in which the activity peaks appeared to have a particularly distinct pattern which was repeated the following day but 1·6–1·85 hr. earlier, this interval corresponding to the difference between the periods of the Earth and Venus. Daily drifts of 1·6–1·85 hr. correspond to periods of 22 hr. 24 min.–22 hr. 09 min., respectively. These observations make it appear unlikely that the 13-day interval is itself equal to the rotation period, since in this case (13-day rotation period) it is rather improbable that the activity peaks would be repeated each day with a characteristic pattern which advances, on the average, by a fixed time increment each day.

If no correlation is made between a particular peak of activity on one day with a similar one on succeeding days, the data of Fig. 1 show a drift-rate not only of somewhat less than 2 hr. per day but also a drift-rate of about 8 min. per day. A similar rate was reported for the March 1956 data[1]. This rate may be explained as follows. The peaks of Venus activity tend to occur on the average at intervals of about 96 min. (and also half this value), so that a succession of such peaks shows an apparent displacement of 8 min. if displaced each day by 96 + 8 min. This would be the case if the rotation period was 22 hr. 16 min., since the total interval (96 + 8 = 1 hr. 44 min.) is equal to the time Venus gains on each rotation as based on this period.

It may be concluded from the radio observations that a probable value for the rotation period is 22 hr. 17 min., with an uncertainty of about ± 10 min. In calculating these periods the apparent motion of the planet has been neglected. However, the correction due to this is small and uncertain as to sign, since the observations do not indicate the direction of rotation. Since Venus is perpetually covered with clouds, no direct optical observations of the rotation period of the planet have been possible and estimates by indirect means have varied widely[2].

Although the mechanism producing the fluctuations in the signals from Venus is not known, a simple, plausible explanation might be the following. It is likely that Venus has an ionosphere at least as dense as that of the Earth. Radio waves originating on or near the surface of the planet and reaching the Earth would most readily penetrate this ionosphere in the general vicinity of the planet's central point. In this vicinity the ionosphere would appear more transparent to signals travelling earthward, so that, in effect, the ionosphere has a hole. Assuming that the hole remains relatively fixed in position with respect to the central point of the planet's disk, the sources would be observed only as they pass, by virtue of the rotation of the planet, beneath the hole, each source producing a peak of activity as it passes by. A similar ionospheric mechanism is presumed to be responsible for the limited duration of the signals from Jupiter[3]. The fact that the hole has been on the dark side of the planet in recent months (Venus was at inferior conjunction on June 22) would tend to make the hole even more transparent. If the sources are thunderstorms or similar disturbances, which move with respect to the surface of the planet, some variation in the apparent period of rotation may be expected when comparing activity peaks on successive days.

The data in Fig. 1 are based mostly on Venus signals of the atmospherics-like variety (class I), since the class II signals are not observed so frequently. With reference to the latter signals, a recent additional observation is that the pulse-like class II signals occur over a frequency-band of at least 2–4 megacycles per sec. with a given pulse being received earlier at higher frequencies, the dispersion in time being about 2 sec. per megacycle per sec. of frequency difference.

John D. Kraus

Radio Observatory,
Department of Electrical Engineering,
Ohio State University,
Columbus 10, Ohio.
July 23.

[1] Kraus, J. D., *Nature*, **178**, 33, 103, 159 (1956).
[2] Ross, F. E., *Astrophys. J.*, **68**, 57 (1928).
[3] Kraus, J. D., *Sky and Telescope*, **15**, 358 (1956).

The Second Purple Light

By photoelectric observation of the twilight sky, Bigg[1] has found evidence of scattering of the Sun's rays from an elevated atmospheric layer. Assuming primary scattering, he calculates its height to average some 81 km. and finds an association between the intensity of the effect and the incidence of meteor showers. He also observed scattering by a lower dust layer (10–25 km.), which is the cause of the purple light frequently observed above the western horizon after sunset and before sunrise. But after some great volcanic eruptions a striking feature of the brilliant sunsets has been the long-continued after-glows, with a second purple light appearing some time after the first had set and only fading away some 1½–2 hr. after sunset.

It is interesting to recall, in the light of Bigg's work, the discussion which took place in *Nature* after the great Krakatoa eruption in August 1883 as to the origin of this second purple light—a discussion continued and amplified in the Report of the Krakatoa Committee of the Royal Society published in 1888. In the first place, R. von Helmholtz[2] suggested that primary scattering of light from dust at heights around 70 km. was the cause of the second purple light; but this view did not gain general acceptance and it was instead held that both purple lights were caused by the lower dust layer. This explanation is still current—Neuberger[3], for example, says "the purple light is sometimes sufficiently intense to cause a secondary purple light for an observer situated farther on the night side of the earth". The primary scattering hypothesis was rejected mainly owing to the "*a priori* improbability that the reflecting stratum, whether derived from cosmical or from terrestrial sources, should occur in two definite layers" (Archibald[4]). Now that we know more of the complexities of the atmosphere and, in particular, of the strong temperature inversion with its base at about 80 km., this argument fails, and Helmholtz's explanation seems much the more probable. The relative intensity of the purple lights seems more in keeping with a two-layer theory; a secondary effect of the first purple light would not be expected to have as great intensity as reported in 1883 and 1884.

If we assume primary scattering from a high-level dust layer, then six observations of the second purple light by Riccò[4] at Palermo give a mean height of 85 km. and others by Brauner[5] at Prague about 80 km. These values compare well with Bigg's mean of 81 km.; so it seems very probable that Krakatoa dust was held in suspension at these heights over a period of some months.

E. L. Deacon

Division of Meteorological Physics,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.
May 9.

[1] Bigg, E. K., *Nature*, **177**, 77 (1956).
[2] Helmholtz, R. von, *Nature*, **29**, 130 (1883).
[3] Neuberger, H., "Compendium of Meteorology", 61 (Amer. Met. Soc., Boston, Mass., 1951).
[4] Archibald, E. D., Part 4, Sect. 4, "The Eruption of Krakatoa", Rep. Krakatoa Cmttee. of Roy. Soc. (Trübner, London, 1888).
[5] Brauner, B., *Nature*, **29**, 223 (1884).

Physical Constants in Extra-Galactic Nebulæ

Recent wave-length measurements by R. Minkowski and O. C. Wilson[1] of spectral lines of H, N II, O I, O II, Ne III and Ne V for the colliding galaxies identified with the radio source Cygnus *A* permit comparison of galaxy values of physical constants with local values. In particular, radio measures by A. E. Lilley and E. F. McClain[2], in combination with the optical measures, permit estimates on the ratio of galactic to local values of the fine structure constant, α, and the proton gyromagnetic ratio, g. The observed system is estimated to be 3×10^8 light years from us on the Humason, Mayall, Sandage scale[3].

In the discussion of these measures, we shall be concerned with a gross red shift, assumed of the form $\Delta\lambda/\lambda$ = constant, upon which may be superimposed changes in fine and hyperfine structure. It is not necessary to decide whether the gross red shift arises from a change of constants or from a velocity shift. It is further assumed that the interaction Hamiltonian for atomic spectra is of the form:

$$H = H_0 + \alpha^2 H_f + g \frac{m}{M} \alpha^3 H_M \qquad (1)$$

Among these terms, H_0 arises from electrostatic interactions, H_f from relativistic effects usually represented by spin-orbit interactions, and H_M in this specific case is the spin-spin interaction as in the hydrogen hyperfine structure. If we use the ionization energy of hydrogen as the energy unit, we obtain from equation (1) the quantity $hcR = \frac{1}{2}\alpha^2 mc^2$.

In writing equation (1) it is assumed that both fine structure and hyperfine structure are small perturbations, and especially for the former that Russell-Saunders coupling predominates (see Condon and Shortley[4] and Bethe[5]). Note particularly that the ratio of the fine and hyperfine interaction energies to the electrostatic interaction energies depends upon no other physical constants except those indicated in equation (1).

From measures of all available lines, Minkowski and Wilson conclude that for the optical Cygnus *A* the quantity $c\Delta\lambda/\lambda = 16{,}805 \pm 6$ km./sec. The fine structure produces the doublet splitting of the terms $^3P_n - {}^1D$. Of the three doublets measured, the measures of O I appear to suffer from blends and only those of N II and Ne III will be discussed. The doublet separations are taken proportional to $(1 + \Delta\lambda/\lambda)\,\alpha^2$. With $\Delta\lambda/\lambda$ as above, we obtain from the data:

$$\frac{(\alpha^2)\ \text{Cyg. } A}{(\alpha^2)\ \text{local}} = 1{\cdot}0036 \pm 0{\cdot}0032$$

E. Salpeter (private communication) points out that if the red shift is understood as arising from a change in α^2, then:

$$\frac{(\alpha^2)\ \text{Cyg. } A}{(\alpha^2)\ \text{local}} = \left(1 + \frac{\Delta\lambda}{\lambda}\right) = 1{\cdot}057$$

The observed wave-length of the hyperfine structure hydrogen line at 21 cm. is assumed to be given by the following equation:

$$\lambda_{\text{Cyg. } A} = \lambda_{\text{local}}\,(1 + \Delta\lambda/\lambda)\,\frac{\left(g\frac{m}{M}\alpha^2\right)_{\text{Cyg. } A}}{\left(g\frac{m}{M}\alpha^2\right)_{\text{local}}}$$

Since Lilley and McClain report $c\Delta\lambda/\lambda = 16{,}700 \pm 50$ km./sec. we find

$$\frac{\left(g\frac{m}{M}\alpha^2\right)_{\text{Cyg. } A}}{\left(g\frac{m}{M}\alpha^2\right)_{\text{local}}} = 1{\cdot}0003 \pm 0{\cdot}0007$$

This corresponds to

$$\frac{\left(g\frac{m}{M}\right)_{\text{Cyg. } A}}{\left(g\frac{m}{M}\right)_{\text{local}}} = 0{\cdot}9967 \pm 0{\cdot}0032$$

It must be mentioned, however, that the difference of 100 km./sec. could also be understood as resulting from an expanding hydrogen envelope of which only the front surface projects on the source.

Note that α is the coupling factor for quantum electrodynamics. The proton gyromagnetic ratio is observed to be 2·8 times the ratio predicted by quantum electrodynamics and is apparently determined by interactions with the meson field. My conclusion is that, within the precision of current measurements, the above physical constants of Nature are indistinguishable in two galaxies 3×10^8 light years apart.

Similar conclusions were mentioned by E. M. Purcell at a symposium in April 1956.

M. P. Savedoff
Institute of Optics and Department of Physics,
University of Rochester, N.Y.
June 29.

[1] Minkowski, R., and Wilson, O. C., *Astrophys. J.*, 123, 373 (1956).
[2] Lilley, A. E., and McClain, E. F., *Astrophys. J.*, 123, 172 (1956).
[3] Humason, M., Mayall, N. U., and Sandage, A. R., *Astro. J.*, **61**, 98 (1956).
[4] Condon, E. U., and Shortley, G. H., "The Theory of Atomic Spectra" (Camb. Univ. Press, 1951).
[5] Bethe, H., "Handbuch der Physik", 24/1, Chap. 3, 385 ff. (1933).

Suggested Experiment on the Relativistic Contraction of Time

It has been questioned whether a discrepancy in time would be observed when comparing clocks at the completion of a space journey. It seems to me that one need not await the advent of space travel at extreme speeds for experimental evidence, since a closely analogous experiment could be performed on the Earth. A suitable clock exists in the form of unstable particles of known half-life. Particles possessing charge in combination with a convenient mass and half-life could be injected into a synchrotron and circulated for a measured time-interval before emerging. Some would disintegrate within the synchrotron and fail to emerge. By comparing the number entering in unit time with the number emerging, any increase in the life of the particles, as measured by the stationary observer, could be determined.

In case it should be objected that motion in a circular path, implying continuous acceleration, does not correspond to a flight path which would be adopted in space travel, an alternative technique is possible. The particles could be accelerated in an electric field, allowed to coast for a relatively long distance in a field-free region, reflected by a second electric field or a magnetic field, and finally brought to rest at the starting point after retraversing the field-free region and the first electric field. To obtain maximum velocities the electric fields could take the form of linear accelerators.

Incidentally, if an increase in life of the particles were in fact observed, there might be interesting applications for this technique of 'freezing' short-lived particles.

R. Herman
Standard Telecommunication Laboratories, Limited,
Progress Way,
Great Cambridge Road,
Enfield, Middlesex.

A Determination of the Line-width of the λ6300 Line of Oxygen in the Twilight Sky

The red doublet (λ6,300–λ6,363) due to oxygen in the upper atmosphere of the Earth is greatly enhanced in twilight, as was shown by Elvey and Farnsworth[1] and others. The present study has been undertaken to determine the temperature of the emitting layer from the contour of the λ6,300 component.

A Fabry–Perot interferometer with multi-layer dielectric reflecting surfaces, described in an earlier study of the λ5,577 line in the night sky[2], was placed in front of a camera with an effective focal ratio of 3·9. The interferometer plates were coated with five layers—two of cryolite and three of zinc sulphide—giving a reflectance of 0·87 in the spectral region under study. A quartz spacer of 11·7 mm. was used.

In front of the system a multi-layer dielectric interference filter (Baird Associates) with a bandwidth of 60 A. was inserted to reduce the scattered light from the twilight sky and to isolate the λ6,300 line from the weaker λ6,363 component. The entire instrument was contained in an airtight enclosure to provide constant density of the air between the interferometer plates, and this, in turn, was placed in an insulating case to permit careful temperature control.

Observations were made at the Geophysical Institute at College, Alaska (lat. 64° 52′ N.), at a time when twilight conditions favourable for the study existed at midnight. This permitted long exposures during which the depression of the Sun below the horizon remained nearly constant. Exposures of from one to two hours were necessary to obtain satisfactory results. The optical axis of the instrument was directed to the north and at a zenith distance of 70°.

The instrumental effect on the contour of the fringes was determined from a comparison of the observed line-width with the width of the λ6,438 line

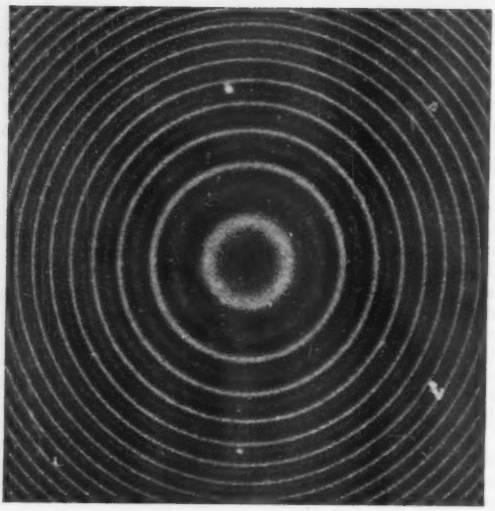


Fig. 1

of cadmium. Periodically the exposure to the twilight was interrupted and the cadmium lamp (Philips type 93107*E*) exposed to the interferometer so that a second set of fringes was formed on the photographic plate. By trial a spacer was found that would give suitable spacing to the two sets of fringes.

Fig. 1 shows the result of a complete exposure (plate *B*): the more intense set of interference fringes are due to λ6,438 of cadmium and the less intense are due to λ6,300 of oxygen.

In the reduction of the line contours, microphotometer tracings made along several diameters of the pattern were converted to intensities and averaged; the several fringes on this average pattern were then converted to a linear scale and combined into a mean fringe for each source.

Using the intrinsic contour of the λ6,438 line, as determined by separate experiment, and assuming the λ6,300 line to be Gaussian in shape, the method of Voigt parameters[3] was employed to find, by a series of approximations, a curve that would best represent the observed curve and would establish the width of the λ6300 line. The instrumental contribution was found to be asymmetrical, with the right side having a resonance shape and the left side a shape intermediate between resonance and Gaussian.

Fig. 2 shows one complete phase of the fringe system: the dotted line is the observed average contour of the fringe system, while the solid line is the best representation of this curve; the dashed lines are the known intrinsic contour of the λ6,438 line and the derived contour of the λ6,300 line. The difference between the solid and the dashed lines represents the instrumental effect.

The zero intensity as shown is probably quite reliable. The overall shape of the fringes and the asymmetry of the instrumental effect combine to restrict the selection of the zero point. It was found that a small change in the zero point would result in a serious deviation in the shape of the curve. This zero intensity is consistent with the minimum intensity of about 2 per cent between the fringes which is to be expected from the reflectance of 0·87, if due consideration is given to the blending of the two sets of fringes.

In listing the results, consideration must be given to the height of the emitting layer, which is that region illuminated by the Sun. However, the height of the horizon for the radiation responsible for the enhancement may very likely be quite great, due to the opacity of the atmosphere; 100 km. has been selected arbitrarily as the height of the opaque layer.

Table 1

	h_0	h_{100}	$\Delta\lambda$	T
Plate *A*	64	155	0·0315 ± 0·0024	790 ± 120
Plate *B*	78	155	0·0299 ± 0·0026	710 ± 130
Plate *C*	74	151	0·0266	560

In Table 1, h_0 is the height of the Earth's shadow in the line of the observation in kilometres; h_{100} is the height of the shadow of a layer 100 km. above the Earth's crust in the line of the observation; $\Delta\lambda$ is the width at half-intensity of the λ6,300 line in A.; and T is the temperature in degrees K. corresponding to $\Delta\lambda$. The results from plates *A* and *B* are consistent with the probable errors listed. Plate *C*, which shows considerably lower values for $\Delta\lambda$ and T, has been included only to indicate the order of magnitude of the result; due to fogging of this plate by the twilight, much difficulty was encountered in calibration of the exposure and it cannot be given much weight. A value of 750° K. may reasonably be adopted for the temperature of the emitting layer for the conditions of the first two observations.

This temperature contrasts with the result of the study of λ5,577 of oxygen in the night sky[2], which showed a temperature of about 200° K. Such a difference in temperature would suggest that the emissions in the two cases arise in substantially different levels of the atmosphere: the λ5,577 line in the night sky coming from a level near 100 km., in accordance with evidence from night sky studies[4] and from rocket ascent studies[5], as well as with theoretical argument[6]; the enhanced λ6,300 line in the twilight sky, under the conditions of this study, coming from a level of at least 150 km. and perhaps above 200 km., in accordance with the results from rocket ascent studies[5].

A further discussion of this study will be published elsewhere in the future.

I wish to thank Dr. C. T. Elvey, director of the Geophysical Institute of the University of Alaska, for suggesting the work and for his aid; Prof. J. G. Phillips, Prof. F. A. Jenkins and Dr. J. M. Stone

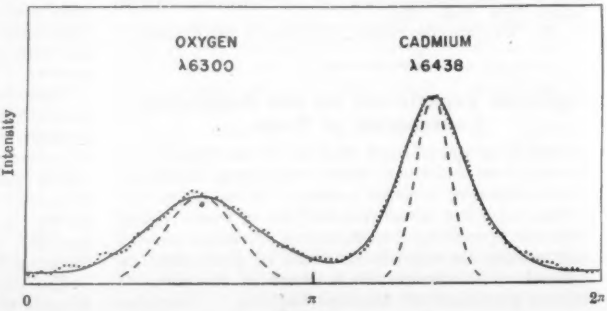


Fig. 2

of the University of California for their assistance and guidance; and the U.S. Weather Bureau for its co-operation.

DAVID Q. WARK

Department of Astronomy,
University of California,
Berkeley.
May 31.

[1] Elvey, C. T., and Farnsworth, A. H., *Astrophys. J.*, **96**, 451 (1942).
[2] Wark, D. Q., and Stone, J. M., *Nature*, **175**, 254 (1955).
[3] van de Hulst, H. C., and Reesinck, J. J. M., *Astrophys. J.*, **106**, 121 (1947).
[4] St. Amand, P., Pettit, H. B., Roach, F. E., and Williams, D. R., *J. Atmos. Terr. Phys.*, **6**, 189 (1955).
[5] La Gow, H. E., in "Rocket Exploration of the Upper Atmosphere", edit. by R. L. F. Boyd *et al.* (Pergamon Press, Ltd.).
[6] Bates, D. R., and Dalgarno, A. J., *J. Atmos. Terr. Phys.*, **4**, 112 (1953).

The Maximum of a Distribution- or Spectrum-Function

RECENTLY, Bracewell[1] published a paper, in which he explained why the position of the maximum of Planck's energy spectrum depends on whether the frequency or the wave-length is plotted on the horizontal axis. I wish to direct attention to the fact that this is true for all distribution- or spectrum-functions. Though it is indeed obvious that the maximum must move, when the horizontal axis is non-linearly transformed, yet errors have been made in this respect. Zernike[2] pointed out that, for example, an error of this kind was made when Stern and Gerlach[3] described their famous experiments, in which rays of silver atoms were deflected by a magnetic field. They assumed (Fig. 1) that the atoms with the most probable velocity v_p would have the most probable deflexion y_p (thickest part of the precipitation layer). This is only true if the deflexion y and the velocity v of an atom are related by $y = av + b$. However, they are related by $yv^2 = \text{constant}$. The true value of y_p is one-half of the value derived from the last equation with $v = v_p$. This result is due to Semenoff[4], who was apparently the first to recognize the danger, described here. Though geophysicists are particularly vulnerable in this respect, as they have been investigating spectra of all sorts of time-series, yet almost all of them have succeeded in escaping the pitfall.

One exception is Schumann[5], who obtained the spectrum of the daily air pressure on the North Atlantic by a Fourier analysis. He found $T = 5{\cdot}7$ days as the most frequent period in air-pressure. However, when he changed from period to frequency, he found $n = 0{\cdot}033$ (equivalent to $T = 30$ days) for the maximum of the frequency distribution, a result apparently so strange to him that he looked for an explanation in the wrong direction.

Fig. 1

A group of oceanographers from New York University[6] have studied the energy spectrum of ocean waves. In this case, too, the position of the maximum changes when one considers the distribution of periods instead of the distribution of frequencies.

Spectra of turbulence, especially turbulence of the lower atmosphere, have been analysed by an American group under Panofsky[7] and by an Australian one under Priestley and Swinbank[8]. Both groups have succeeded in avoiding difficulties, though possibly not for reasons inspired by the risk described in Bracewell's paper and here, as is shown by quotations of Panofsky and McCormick (ref. 7, p. 551): "Since meteorological turbulence covers a wide range of frequencies, a logarithmic frequency scale was judged appropriate"; and of Webb (ref. 8, No. 5, p. 7): "It is appropriate to display the results by plotting $n\,F(n)$ which is the fraction of energy per unit fractional increment of frequency. If a logarithmic scale is used for n, the area under a portion of the curve still represents the energy fraction $\int F(n)\mathrm{d}n$."

The use of log n or log λ as abscissa ensures that for most cases the spectrum peak frequency and the spectrum peak wave-length are related by $n_{\max.} \times \lambda_{\max.} = c$. This was proved by Bracewell[1] for the case of $c = \text{constant}$. It is also true when $c = c_0\lambda^k$ (this occurs, for example, with waves in deep water, where $k = \frac{1}{2}$); but it is certainly not valid for cases of, for example, $c = c_0 \exp(-\beta\lambda)$.

I wish to express my thanks to my colleague, Dr. H. J. de Boer, for valuable discussions.

W. VAN DER BIJL
Royal Netherlands Meteorological Institute,
De Bilt.
March 21.

[1] Bracewell, R. N., *Nature*, **174**, 563 (1954).
[2] Zernike, F., "Handbuch der Physik", (12), **3**, 454 (1928).
[3] Stern, O., and Gerlach, W., *Z. Phys.*, **2**, 49, Abd. 3, 417 (1920).
[4] Semenoff, N., *Z. Physik.*, **30**, 151 (1924).
[5] Schumann, T. E. W., *Notos*, **4**, 4 (1955).
[6] For example, Neumann, G., *Trans. Amer. Geophys. Union*, **36**, 985 (1955).
[7] Panofsky, H. A., and McCormick, R. A., *Quart. J. Roy. Meteor. Soc.*, **80**, 546 (1954).
[8] Swinbank, W. C., and others, Coun. Sci. Indust. Res. Australia, Div. of Meteorological Physics, Tech. Paper No. 2 – 6 (1955).

Phase-distribution in and near the Bright Nucleus of an Aberration-free Diffraction Image

IT was shown in the course of a recent investigation[1] that the three-dimensional phase distribution very close to the geometrical focus of an aberration-free diffraction image in light of wave-length λ is substantially the same as that in a parallel beam of wave-length $(1 - \frac{1}{4}\sin^2\alpha)\lambda$, travelling in the direction defined by the principal ray, where $\sin\alpha$ denotes the numerical aperture of the converging pencil.

Let φ and $\bar{\varphi}$ denote the respective phases, both normalized to $\pi/2$ at the geometrical focus O, of the complex displacements in the converging pencil and in the parallel comparison beam.

When the numerical aperture $\sin\alpha$ is varied, the form of the equiphase surfaces $\varphi = \text{const.}$ undergoes a transformation which is more complicated than a simple linear scale-distortion. However, the difference $\varphi - \bar{\varphi}$ between the phases of the actual and the comparison waves at a point P near focus can be expressed, to a useful approximation, as a function of the two optical parameters u, v alone, where $u/4\pi$ measures the 'number of fringes of defocusing' of P relative to O, and v/π the 'number of fringes of lateral displacement' of P relative to O, as they would be seen

in an interferometer. In fact, from the approximate equation,

$$\mathrm{d}(P)/\mathrm{d}(O) = 2\exp\{-iu\ \mathrm{cosec}^2\alpha\}\int_0^1 \exp\{\tfrac{1}{2}iut^2\}\, J_0(vt)\, t\, \mathrm{d}t \quad (1)$$

for the ratio of the complex displacement $\mathrm{d}(P)$ at a point P near O to the complex displacement at O itself, we obtain:

$$\varphi - \tilde{\varphi} = \omega + \tfrac{1}{4}u - \frac{\pi}{2}, \quad (2)$$

where

$$\cos\omega = \frac{U_2}{\sqrt{U_1^2 + U_2^2}},\ \sin\omega = \frac{-U_1}{\sqrt{U_1^2 + U_2^2}} \quad (3)$$

and the Lommel functions U_1, U_2 are given by the equations

$$U_n = U_n(u,v) = \sum_{m=0}^{\infty}(-1)^m\left(\frac{u}{v}\right)^{n+2m} J_{n+2m}(v) \quad (4)$$
$$(n = 1, 2).$$

In the course of the investigation already mentioned, the distribution of $\varphi - \tilde{\varphi}$ was computed over the region $u^2 + v^2\sin^2\alpha \leq 4$, which is a spheroid about 3·5 times as wide and one-sixth as long as the elongated bright nucleus of the three-dimensional diffraction image (see ref. 1, Fig. 4). An extension of the computations, carried out with the assistance of Miss C. P. Wilks, has now made possible the construction of Fig. 1, which exhibits the distribution of $\varphi - \tilde{\varphi}$ over a region about 2·5 times as long, and six times as broad, as the bright nucleus of the diffraction image. Only one (u,v)-quadrant is shown, since the remaining three are readily deducible from it with the help of symmetry relations derived from equation (1).

In this figure, which forms a natural complement to Zernike and Nijboer's well-known diagram[2] of the intensity distribution, Z_1 and Z_2 are the first two axial nodes (points of zero intensity) in the diffraction image, while R_1, R_2, . . . generate the successive Airy dark rings when the figure is rotated about the optic axis Ou. The numbers on the contour lines indicate the values, measured in radians, of the phase-discrepancy $\varphi - \tilde{\varphi}$ between the complex displacements in the diffraction image and in the comparison parallel beam defined above.

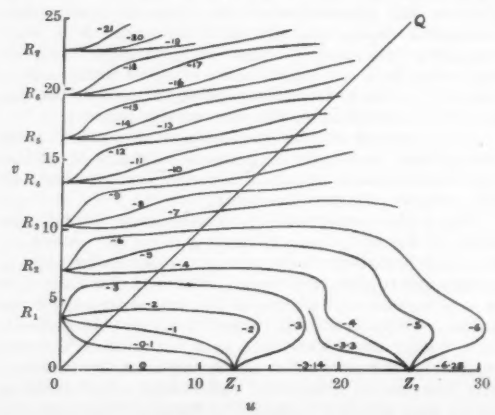


Fig. 1. Values of $\varphi - \tilde{\varphi}$

The diagonal line OQ corresponds to the edge of the geometrical shadow.

One of us (E. W.) wishes to acknowledge the award of an I.C.I. Research Fellowship covering the period in which this work was carried out.

E. H. Linfoot

The Observatories,
University of Cambridge.

E. Wolf

The University,
Manchester 13.
March 29.

[1] Linfoot, E. H., and Wolf, E., *Proc. Phys. Soc.*, B (in the press).
[2] Zernike, F., and Nijboer, B. R. A., in "Théorie des Images Optiques" (Éditions de la Rev. d'Optique, Paris, 1949).

A Very Rapid Two-Stage Solid–Solid Reaction and the Mosaic Structure of Potassium Permanganate

Studies of self-sustained reaction by the temperature profile method[1] have recently been extended to compressed mixtures of molybdenum and potassium permanganate and have shown that reaction occurs in two stages.

The observed temperature-time record (obtained by placing a thermojunction in the path of the reaction wave) consists of two sigmoid parts, joined by a flat step which corresponds to completion of the first stage of reaction. When the reactants are initially at room temperature (20° C.), the step temperature is 120° C. and the final temperature 850° C. Thus the heat evolved in the first stage is roughly one-eighth of the total.

This observation may be explained in terms of the mosaic structure of the reactants. If molybdenum ions are the mobile species, as seems probable since they are much smaller than permanganate ions, they may react by diffusing into the permanganate along the grain boundaries. The first stage of reaction probably corresponds to complete coverage of the internal surfaces with a layer of product. No further reaction takes place until the temperature has risen above 120° C.; then, at a temperature at which molybdenum can penetrate the lattice, reaction with the bulk of the permanganate begins. The bulk reaction is expected to be complete because molybdenum is in large excess, and it is probable that the heats evolved in the first and second stages are directly proportional to the numbers of permanganate ions on the surface and in the bulk respectively. On this basis, with the assumption that the surface layer is monomolecular, the average dimension of the mosaic blocks in potassium permanganate may be calculated. It is found to be approximately 10^{-5} cm., which is of the same order as that found in other crystals by X-ray methods[2].

It is apparent that if the mosaic blocks in crystals have dimensions of this order, we may expect roughly 10 per cent of the substance to be in a more reactive state than the rest; and it is noteworthy that partial reaction of this degree is fairly common. Other solid–solid reactions with this behaviour are those between iron and potassium dichromate and between iron and barium peroxide[3]. These are particularly interesting because the reaction time was several hours, or 10^4 times longer than the reaction time (1 sec.) in the self-sustained reaction of molybdenum and potassium permanganate. Similar partial reaction has been noticed during the thermal decom-

positions of solids, for example, of lithium aluminium hydride[4] and of mercury fulminate[5].

R. A. W. Hill
A. A. Wallace

Research Department,
Nobel Division,
Imperial Chemical Industries, Ltd.,
Stevenston, Ayrshire.
May 9.

[1] Hill, R. A. W., *Proc. Roy. Soc.*, A, **226**, 455 (1954).
[2] Darwin, C. G., *Phil. Mag.*, **27**, 315, 675 (1914). Cottrell, A. H., "Dislocations and Plastic Flow in Crystals" (Clarendon Press, Oxford, 1953). See also, Amelinckx, S., *Phil. Mag.*, (8), **1**, No. 3, 269 (1956). Humphreys-Owen, S. P. F., *Proc. Phys. Soc.*, B, **69**, 350 (1956).
[3] Spice, J. E., and Staveley, L. A. K., *J. Chem. Soc. Indust.*, **68**, 313 (1949).
[4] Garner, W. E., and Halles, H. R., *Proc. Roy. Soc.*, A, **139**, 576 (1933).
[5] Garner, W. E., and Haycock, E. W., *Proc. Roy. Soc.*, A, **211**, 335 (1952).

Mass-Spectrometric Detection of the Ion $(SrOK)^+$

In a study of the ionization produced by traces of alkali and alkaline earth elements in hydrogen/air flame gases, Wheeler[1] has found evidence for ions of the type $(BOA)^+$, where A represents an atom of alkali metal and B one of alkaline earth. Theoretical calculations, by the method of Rittner[2], suggest that such ions should be of high stability in the gas phase, the heat of dissociation into BO and A^+ being of the order of 100 k.cal./mole. A mixed ion of this type was suggested by the highly specific behaviour given by various A/B pairs. The basic measurements were, however, of electron concentrations, the existence of this particular positive ion being inferred from them, and it seemed desirable to have independent and more direct evidence for their presence.

An attempt to obtain and identify such ions has been made by mass-spectrometric analysis of the ionic content of the vapour from a strongly heated mixture of a potassium and a strontium salt in a vacuum oven. The diagram of the oven is shown in Fig. 1. The oven cell (A), of molybdenum, was constructed in two pieces, rammed together after loading with the charge (B). It was maintained at a potential of + 1,500 V. (stabilized) relative to the remainder of the oven, this serving to accelerate the ions into the mass spectrometer, and also allowing the front end to be heated to the required temperature by electron bombardment from the filament (C). A second filament (D) allowed of further heating (of the rear end) by radiation. The temperature of the front (exit) end of the oven was determined pyrometrically, and that of the rear by a thermocouple (E), which also carried the emission current, via the oven, from (C). The inner radiation shields (F,G) were of nickel, and the outer, water-cooled, shield (H) was of copper.

Any positive ions in the vapour from the charge were repelled from the oven, through the slit system, into a mass spectrometer, which was a 90° Nier type. An electron multiplier detection system was used so that actual counts of ions could be made. A mixture of strontium and potassium carbonates was heated, a little cæsium being added to give a reference peak at mass 133. With this mixture, the rear of the oven being at about 1,000° K., and the tip at about 1,900° K., which were found to be optimum working conditions, an ion current was noted at mass 143. This was not evident with either of the carbonates

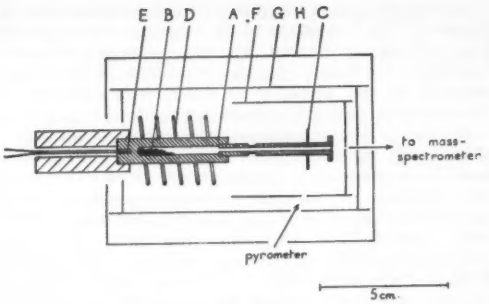


Fig. 1

heated alone under the same conditions. It corresponds with a positive ion $(^{88}Sr^{16}O^{39}K)^+$, which combines all the most abundant isotopes, and should give at least eight times as large a peak as any other combination. The observed peak corresponded with a current of about twelve ions per sec., with a noise-level of about two per sec., so that no other $(SrOK)^+$ peak would be expected.

It is considered that this provides reasonable evidence for the existence of this type of ion, first postulated in the flame studies referred to. The ions probably owe their stability to the very large electrostatic attraction between the alkali metal ion A^+ and the large dipole of the alkaline earth oxide BO. It is interesting to note that Inghram, Chupka and Porter[3], also using a mass-spectrometric method, have been able to demonstrate the formation of the ion $(Ba_2O)^+$ from the vapour of barium oxide heated in an alumina crucible.

One of us (P. F. K.) is grateful to the Department of Scientific and Industrial Research for a grant covering the period of this investigation.

T. M. Sugden
P. F. Knewstubb
K. F. Smith

Department of Physical Chemistry,
and
Cavendish Laboratory,
Cambridge.
May 28.

[1] Sugden, T. M., and Wheeler, R. C., *Disc. Farad. Soc.*, **19**, 76 (1955).
[2] Rittner, E. S., *J. Chem. Phys.*, **19**, 1030 (1951).
[3] Inghram, M. G., Chupka, W. A., and Porter, R. F., *J. Chem. Phys.*, **23**, 2159 (1955).

Isolation of the Stable Boron Trifluoride – Hydrogen Fluoride Complexes of the Methylbenzenes ; the Onium Salt (or σ-Complex) Structure of the Friedel-Crafts Complexes

The alkylation of aromatic hydrocarbons catalysed by aluminium chloride and similar Friedel-Crafts catalysts is ordinarily accompanied by the formation of deeply coloured oily liquids of high density. The structure of these 'Friedel-Crafts complexes' has been investigated by a number of workers[1]. H. C. Brown and H. W. Pearsal[2] have proved the formation of a molecular complex from toluene and aluminium chloride – hydrogen chloride at low temperature. In further work, H. C. Brown and J. D. Brady[3] have established the structure of the hydrogen chloride – aluminium chloride complexes of the methylbenzenes as σ-complexes in contrast to the proposed hydrogen chloride complexes which have

a π-complex structure (after the representation of Dewar[4]). The formation of the onium or σ-complexes was proved by Brown by the hydrogen chloride technique by measuring the solubility of hydrogen chloride in the presence of aluminium chloride in the isomeric methylbenzenes.

Similarly, the complexes of hydrogen bromide – aluminium bromide with aromatic hydrocarbons have been intensively investigated. Norris reported the isolation of several crystalline products from mesitylene (Mes) and 1,3,5-triethylbenzene (TEB) with aluminium bromide – hydrogen bromide: $3Mes.Al_2Br_6.HBr$; $2TEB.Al_3Br_6HBr$ [5]; $Mes.Al_2Br_6.HBr$; $TEB.Al_2Br_6.HBr$ [6]. Brown and Wallace[7] suggest, as a result of their investigations of hydrogen bromide – aluminium bromide complexes of aromatic hydrocarbons, the σ-complex structure of the resulting Friedel-Crafts complexes ('red oils').

The concept that aromatic hydrocarbons possess basic properties sufficiently strong to form salts with hydrogen halide – aluminium halide and similar reagents suggests that such reagents could be utilized to extract, preferentially, more strongly basic aromatic hydrocarbons from those less basic. McCaulay, Shoemaker and Lien[8] have recently demonstrated that hydrogen fluoride – boron trifluoride can be readily utilized to extract the more basic *m*-xylene from its mixture with the less basic *o*- and *p*-xylene isomers. These authors have established the ratio $Ar : BF_3 = 1 : 1$ in the complexes formed from aromatic hydrocarbons, boron trifluoride and hydrogen fluoride, the latter being present in excess as the solvent. The formation of the complexes was proved by the determination of the solubility of boron trifluoride in the hydrogen fluoride – methylbenzene system.

We have now been successful in isolating the stable boron trifluoride – hydrogen fluoride complexes of the methylbenzenes in the previously investigated cases of toluene, *m*-xylene, mesitylene and *iso*durene.

In the absence of hydrogen fluoride and at low temperature (− 25° to −85°), boron trifluoride neither interacts with nor dissolves appreciably in toluene, xylene, mesitylene and *iso*durene. Hydrogen fluoride itself is also not soluble to more than 1 per cent in the methylbenzenes[9]. In the presence of an equimolecular quantity of water-free hydrogen fluoride, the boron trifluoride dissolves in methylbenzenes to give a clear solution with a bright colour (greenish-yellow, yellow or brownish-red), which solidifies by cooling. The one mole of methylbenzene, one mole of hydrogen fluoride and one mole of boron trifluoride is needed to form the stable complex. The reaction is reversible: when heated, the complexes melt with subsequent evolution of boron trifluoride and hydrogen fluoride and the aromatic compounds are regenerated. We were able to determine the melting points of the stable methylbenzene hydrogen fluoride – boron trifluoride complexes in the cases of toluene, *m*-xylene, mesitylene and *iso*durene. Also the specific conductivity of the stable complexes were determined.

Properties of $ArH^+BF_4^-$ Complexes Prepared

R	Melting point (° C.)	$\varkappa$ Ω^{-1} cm.$^{-1}$
$(CH_3)C_6H_5$	−65	$0{\cdot}8 \times 10^{-3}$
$m(CH_3)_2C_6H_4$	−55	$2{\cdot}0 \times 10^{-3}$
$s(CH_3)_3C_6H_3$	−15	$1{\cdot}6 \times 10^{-3}$
$as(CH_3)_4C_6H_2$	−10	$0{\cdot}6 \times 10^{-3}$

The reaction is believed to involve the formation of a carbonium ion salt of the hypothetical acid, HBF_4: $(CH_3)C_6H_5 + HF + BF_3 = (CH_3C_6H_5)^+BF_4^-$. The complexes which are formed in the course of Friedel-Crafts reactions are believed to be carbonium ion salts of this kind.

Using deuterium fluoride (prepared by the reaction of C_6H_5COF with deuterium oxide[10]) in the place of hydrogen fluoride in the complex formation, deuterated tetrafluoroborate complexes of the $(CH_3C_6H_5D)^+BF_4^-$ type are formed. By the slow decomposition of the complexes we obtain *o*- and *p*-D-toluene, which confirms unambiguously the electrophilic character of the D^+ substitution via the stable onium ion salt of the hypothetical DBF_4 acid and the structure of the complexes.

G. Oláh
S. Kuhn
A. Pavláth

Chemical Central Research Institute
of the Hungarian Academy of Sciences,
Budapest, XIV, Hungária-krt. 114.
May 25.

[1] A summary of earlier work is contained in Thomas, C. A., "Anhydrous Aluminium Chloride in Organic Chemistry", Amer. Chem. Soc. Mon. No. 87, pp. 48–54 (Reinhold Pub. Corp., New York, N.Y., 1941).

[2] Brown, H. C., and Pearsal, H. W., *J. Amer. Chem. Soc.*, **74**, 191 (1952).

[3] Brown, H. C., and Brady, J. D., *J. Amer. Chem. Soc.*, **74**, 3570 (1952).

[4] Dewar, M. J. S., *J. Chem. Soc.*, 406 (1946).

[5] Norris, J. F., and Ingraham, N. J., *J. Amer. Chem. Soc.*, **62**, 1298 (1940).

[6] Norris, J. F., and Wood, J. E., *J. Amer. Chem. Soc.*, **62**, 1428 (1940).

[7] Brown, H. C., and Wallace, W. J., *J. Amer. Chem. Soc.*, **75**, 6268 (1953).

[8] McCaulay, D. A., Shoemaker, B. H., and Lien, A. P., *Indust. Eng. Chem.*, **42**, 2103 (1950). See also McCaulay, D. A., and Lien, A. P., *J. Amer. Chem. Soc.*, **73**, 2013 (1951); **74**, 6246 (1952).

[9] Klatt, W., *Z. anorg. allg. Chem.*, **234**, 189 (1937).

[10] Oláh, G., and Kuhn, S., *Z. anorg. allgem. Chem.* (in the press).

Notation for Serum-Protein Groups and the Genes controlling their Inheritance

Several workers[1–3] have described the presence in serum of a protein with the striking characteristic of binding hæmoglobin. During electrophoresis on filter paper, this hæmoglobin-binding protein migrates in the α_2-globulin position. It is the haptoglobin of Jayle *et al.*[1]. The serum-protein groups described by Smithies[4,5] are characterized by several proteins demonstrated by electrophoresis in starch gels which also have this property of binding hæmoglobin. They appear to be the only serum proteins with hæmoglobulin-binding powers. Furthermore, they also migrate in the α_2-globulin position when the electrophoresis is carried out on filter paper[5,6]. Consequently, the identity of haptoglobin and the proteins characterizing the serum groups can be regarded as established, even though previous work had not shown the multiple nature of haptoglobin. The serum-protein groups are therefore basically determined by differences in the haptoglobins of different individuals.

A genetic pattern for the inheritance of the serum-protein groups has been outlined by us in a previous communication[7]. More extensive family studies, in which all possible matings have been observed, confirm this mode of inheritance—namely, that the serum groups are determined by two autosomal genes with incomplete dominance. Complicating factors which we intend to discuss in a coming publication may make it necessary in the future to extend this genetic mechanism; but its essential correctness is, we believe, established.

Since differences in the haptoglobins of individuals determine their inherited serum groups, we suggest that the system comprising these groups be known as the 'haptoglobin system'. If other inherited serum groups are discovered in the future, the systems can also be named according to the nature of the proteins concerned. We should like to stress that the demonstration of serum-protein groups makes it necessary to distinguish two classes of blood groups: the red blood-cell class (with the corresponding serum antibodies when these are present), and the serum-protein class which does not involve the red cells[7]. To assist in distinguishing the two classes, we propose that serum-protein groups be described by the name of the system followed by numerals to designate the specific group, thus contrasting with the use of letters in the red-cell groups.

In describing the genetic pattern for the haptoglobin system, we suggest that the locus symbol be *Hp* and the genes Hp^1 and Hp^2. The notation for the system would then be as follows:

HAPTOGLOBIN SYSTEM OF THE SERUM PROTEIN GROUPS

Old nomenclature	New nomenclature	Genotypes
Group I	Haptoglobin 1–1	Hp^1/Hp^1
Group II*A*	Haptoglobin 2–1	Hp^2/Hp^1
Group II*B*	Haptoglobin 2–2	Hp^2/Hp^2

A summary of some of the factors which were considered in selecting this notation may be given:

(i) The use of numerals prevents confusion between red-cell groups and serum protein groups.

(ii) The new names for the serum-protein groups have the advantage of indicating the specific proteins which distinguish the three serum groups, and yet they are close to those originally used in describing them. Thus haptoglobin 1–1 (one–one) is similar to group I; haptoglobin 2–1 (two–one) to group II*A*; and haptoglobin 2–2 (two–two) to group II*B*.

(iii) The names given to the three phenotypes correspond closely to the respective genotypes.

(iv) The close similarity of the haptoglobins 2–1 and 2–2 (which differ considerably from haptoglobin 1–1) is reflected in the names.

(v) The relative rates of migration in starch gels of the haptoglobins of the three groups are implied by the numbers, since haptoglobin 1–1 migrates considerably more rapidly than haptoglobins 2–1, and these in turn migrate slightly more rapidly than haptoglobins 2–2.

(vi) If further work indicates that either of the alleles representing the haptoglobin system is multiple, the notation can readily be extended to show this by using subscript letters to the numerals (for example, 2_a, 2_b, etc.) to describe the sub-groups in the way that subscript numerals are used with letters in the red-cell groups (for example, A_1, A_2, etc.).

In describing blood groups, there are occasions when the use of an abbreviated form is essential, so it seems advisable to suggest standard abbreviations for the haptoglobin system at this juncture. The three types can readily be abbreviated to *Hp* 1–1, *Hp* 2–1 and *Hp* 2–2.

We are grateful to Dr. Helge Laurell, of the University of Upsala, for directing our attention to the work on haptoglobin, and for the suggestion in a private communication to one of us that this protein might be identical with one of the hæmoglobin-binding substances of serum demonstrated by starch-gel electrophoresis. We wish to thank Drs. Bruce Chown, William Donohue, Harold Gunson, Philip Levine and Ruth Sanger for their helpful comments on the notation here proposed.

O. SMITHIES
Connaught Medical Research Laboratories,
University of Toronto.
NORMA FORD WALKER
Research Institute,
Hospital for Sick Children,
Toronto, Ontario.
July 12.

[1] Jayle, M. F., Boussler, G., and Badin, J., *Bull. Soc. Chim. Biol.*, **34**, 1063 (1952).
[2] Wieme, R. J., *Experientia*, **9**, 380 (1953).
[3] Tuttle, A. H., *Science*, **121**, 701 (1955).
[4] Smithies, O., *Nature*, **175**, 307 (1955).
[5] Smithies, O., *Biochem. J.*, **61**, 629 (1955).
[6] Smithies, O., and Poulik, M. D., *Nature*, **177**, 1033 (1956).
[7] Smithies, O., and Walker, N. F., *Nature*, **176**, 1265 (1955).

Hæmoglobin *E* in Malaya

Of the variants of normal adult hæmoglobin (*A*), four are now known to be present in large numbers of people. Sickle-cell hæmoglobin (*S*) is found in tropical Africa, in some Mediterranean and Middle Eastern countries and in the New World in populations derived from these parts. It is also present in a few aboriginal communities in southern India. Hæmoglobin *C* is frequent in West Africa, where it is at its highest incidence in the northern Gold Coast. Hæmoglobin *D* has been found in India in 3 per cent of north-west Indians and in 1 per cent of Gujeratis.

Hæmoglobin *E* is present in Siamese[1], Burmese[2] and in Indonesians[3]. In Ceylon it was found in some aboriginal Veddas but not in the Singhalese themselves. Single instances have been seen in India, Turkey, Persia and in the Philippines, but none has so far been found in the Chinese[1,3].

It was of interest to see whether the Malaysians were similar to their Burmese and Siamese neighbours in the north, where hæmoglobin *E* was found in 15·3[2] and 13·6[1] per cent respectively, or whether they resembled the Indonesians in the south, where the incidence is 2·9 per cent[3].

We have examined the blood of 346 Malaysians, all non-related, and have found twenty-four to show hæmoglobins *A* and *E*, one hæmoglobins *F* and *E* (hæmoglobin *E*: thalassæmia), and one hæmoglobin *E* only (hæmoglobin *E* disease). With an incidence of 7·3 per cent, the Malaysians are somewhere midway between the Siamese and Burmese in the north and the Indonesians in the south.

Table 1 suggests that there is a gradient even within Malaya. The peninsula is divided into an eastern and western part by a central range of mountains. Most of the immigrants from Indonesia, especially Sumatra, have settled in the south (Johore) and west of the range of mountains, which acted as a barrier to settlers from across the Straits of Malacca. It seems that there is an inverse relationship between the extent of Indonesian admixture in the past and the incidence of hæmoglobin *E*. In the southern parts of the Western States of Malaya, only one person with this hæmoglobin was found among fifty-four examined from Negri Sembilan, Malacca and Johore.

In one person—from Kelantan—part of the hæmoglobin was neither *A*, *F* nor *E*. The electrophoretic mobility and the progressive denaturation

Table 1. Hæmoglobin *E* in Malaysians in Malaya

State	No. examined	No. with hæmoglobin *E*	Per cent
Eastern States :			
Kelantan	78	8	
Trengganu	16	2	13·1
Pahang	13	4	
Western States :			
North—			
Kedah	33	1	
Penang and Province Wellesley	26	2	6·0
Perak	25	2	
Central—			
Selangor	101	6	
Negri Sembilan	26	–	5·2
Malacca	7	1	
South—			
Johore	21	–	0
Total	346	26	7·5

of the purified hæmoglobin by freezing and thawing were properties described for hæmoglobin *H*, first seen in a Chinese family in the United States[4].

We hope to continue this survey, and to extend it to other communities of Malaya—of three aborigines so far examined one, a Senoi, showed hæmoglobins *A* and *E*. It seems already that the distribution of hæmoglobin *E* in Malaya follows an ethnological pattern, as was noted for that of sickling in Uganda[5] and of hæmoglobin *C* in the Gold Coast[6] and in Nigeria[7].

H. Lehmann

St. Bartholomew's Hospital,
London, E.C.1.

R. Bhagwan Singh

Institute for Medical Research,
Kuala Lumpur,
Federation of Malaya.

[1] Na-Nakorn, S., Minnich, V., and Chernoff, A. I., *J. Lab. Clin. Med.*, **47**, 490 (1956).
[2] Lehman, H., Story, P., and Thein, H., *Brit. Med. J.*, i, 544 (1956); and unpublished results.
[3] Lie-Injo Luan Eng, *Nature*, **176**, 468 (1955); "Penjelidikan haemoglobin patologie di Indonesia", thesis, University of Indonesia, Djakarta (1956).
[4] Rigas, D. A., Koler, R. D., and Osgood, E. E., *Science*, **121**, 372 (1955).
[5] Lehmann, H., and Raper, A. B., *Nature*, **164**, 495 (1949).
[6] Edington, G. M., and Lehmann, H., *Man*, **56**, 34 (1956).
[7] Walters, J. H., and Lehmann, H., *Trans. Roy. Soc. Trop. Med. Hyg.*, **50**, 204 (1956).

Oxidation *in vitro* of Radioactive Œstradiol by Preparations of Human Tissue

The oxidation of œstradiol to œstrone and œstriol in the pathway of degradation of the œstrogens has been inferred from *in vivo* studies in which œstrone and œstriol were found in the urine of the male human[1] and œstrone in the urine of other mammals[2] after the administration of large amounts of œstradiol. More recently, Ryan and Engel[3] found an *in vitro* interconversion of œstradiol and œstrone by tissue-slice preparations of several organs of the rat and man. Using counter-current distribution to achieve separation of the steroids, an accumulation of either œstradiol or œstrone was found when the other œstrogen was present in the substrate. These workers were not able to demonstrate formation or utilization of œstriol. We have observed the *de novo* formation of œstrone and œstriol from labelled œstradiol by human-tissue slice and homogenate preparations from a variety of organs.

Tissues obtained from surgical specimens were placed in cold phosphate–nicotinamide buffer[4] immediately after excision. The sera used were freshly obtained pooled sera from the individually centrifuged blood specimens of several female donors. Tissue slices were suspended in 5 volumes of buffer; homogenates were a 20 per cent suspension in buffer; and sera were diluted in 20 volumes of buffer. 7 ml. of a tissue preparation and 1 mgm. adenosine monophosphate, 1 mgm. diphosphopyridine nucleotide and 0·10 mgm. œstradiol-16-^{14}C (2 μc./mgm.) were placed in each flask and incubated at 37° C. under oxygen for 2½ hr. After incubation, 0·15 gm. metaphosphoric acid, 0·5 gm. 'Celite' and 3 gm. sodium chloride were added to each flask. 10·0 mgm. of carrier, either œstrone or œstriol, was then added.

The œstrogens were isolated from an ether extract by the paper chromatographic procedure of Mitchell and Davies[5]. The area which contained the sample and which corresponded to authentic œstradiol, œstrone or œstriol was cut out and extracted with alcohol. This alcoholic extract was evaporated to dryness in planchets, weighed and assayed for specific radioactivity.

Table 1. Oxidation of Œstradiol-^{14}C by Various Tissues

System		Œstrogen recovered (range (counts/min.)/mgm.)	
		Œstrone	Œstriol
Ovary	Slice	4,970–6,139	187–203
	Homogenate	5,130–7,100	87–130
Testis	Slice	3,470	0–4
	Homogenate	4,150	0–4
Liver, male, homogenate		6,350–7,800	20–88
Kidney, male, homogenate		335	—
Muscle, male, homogenate		245	0–18
Serum		30–60	20–84
Blank		20–38	30–37

Liver, ovary and testis preparations, in this order, are highly active in converting œstradiol to œstrone; kidney and muscle preparations are less active. The conversion to œstriol occurs in ovarian preparations, and to a lesser degree in preparations of liver. There is no or negligible conversion in pooled female-blood serum. The homogenates were as active or perhaps slightly more active than comparable tissue-slice preparations.

The incorporation of acetate-^{14}C into œstradiol by tissue preparations of dog ovary prior to its incorporation into œstrone[6] is consistent with the concept that œstradiol is the œstrogen primarily synthesized in the ovary, and that œstrone and œstriol are then formed by oxidation.

Robert M. Dowben
Joseph L. Rabinowitz

Radioisotope Unit,
Veterans Administration Hospital,
Philadelphia, Penn.

May 1.

[1] Heard, R. D. H., and Hoffman, M. M., *J. Biol. Chem.*, **141**, 329 (1941). Pincus, G., and Pearlman, W. H., *J. Biol. Chem.*, **144**, 569 (1942).
[2] Fish, W. R., and Dorfman, R. I., *J. Biol. Chem.*, **140**, 83 (1941); **143**, 15 (1942).
[3] Ryan, K. J., and Engel, L. L., *Endocrinology*, **52**, 277, 287 (1953).
[4] Rabinowitz, J. L., and Gurin, S., *J. Biol. Chem.*, **208**, 307 (1954).
[5] Mitchell, F. L., and Davies, R. E., *Biochem. J.*, **58**, 690 (1954).
[6] Rabinowitz, J. L., and Dowben, R. M., *Biochim. Biophys. Acta*, **16**, 96 (1955).

Pseudo-cholinesterase in Rat Erythrocytes

ALTHOUGH there are many references in the literature to the existence of different types of cholinesterase in mammalian sera[1], it is generally believed that human red cells contain only one type[2]. Furthermore, we can find no evidence in the literature for the existence of a pseudo-cholinesterase in any mammalian erythrocytes, although many workers have stated that benzoylcholine is hydrolysed by red cells. Since, however, the rate of hydrolysis is slow, this breakdown of a substrate formerly presumed to be specific for pseudo-cholinesterase has been attributed to true cholinesterase. Indeed, Adams[3] has shown that purified true cholinesterase does hydrolyse benzoylcholine, at a rate which would account for such observations. In spite of this, some results obtained by Fraser with benzoylcholine[4] imply the existence of more than one type of cholinesterase in red cells.

Experiments which we have recently carried out on erythrocytes twice washed with 0·9 per cent sodium chloride demonstrate quite clearly the existence of a true and pseudo-cholinesterase in rat red cells. The latter differ markedly from human erythrocytes in that they hydrolyse butyrylcholine as rapidly as acetylcholine (Table 1).

Table 1. RELATIVE RATES OF HYDROLYSIS OF CHOLINE ESTERS BY RAT AND HUMAN RED CELLS

	Acetylcholine	Acetyl-β-methylcholine	Butyrylcholine	Propionylcholine
Rat	100	85	101	79
Human	100	78	10	63

This hydrolysis of butyrylcholine can be suppressed by tetra*iso*propylpyrophosphoramide at a concentration ($2 \times 10^{-4}\ M$) which does not inhibit the hydrolysis of acetyl-β-methylcholine to any marked extent. Tetra*iso*propylpyrophosphoramide is an inhibitor which has been shown[5] to be specific for pseudo-cholinesterase. 1 : 5 - bis - (4′trimethylammoniumphenyl)pentan-3-one diiodide (62*C*47 Wellcome), a specific inhibitor of true cholinesterase[6], at $7 \times 10^{-5}\ M$ inhibits the hydrolysis of acetyl-β-methylcholine but not of butyrylcholine.

Table 2. INHIBITION OF HYDROLYSIS OF CHOLINE ESTERS BY RAT RED CELLS IN THE PRESENCE OF INHIBITORS OF TRUE AND PSEUDO-CHOLINESTERASE

Inhibitor	Per cent inhibition (calculated from the ratio of hydrolysis-rate in the presence, and absence, of inhibitor for the given substrate)			
	Acetylcholine	Acetyl-β-methylcholine	Butyrylcholine	Propionylcholine
Tetra*iso*propylpyrophosphoramide	20	15	100	30
62C47	92	97	0	45

We have insufficient evidence to enable us to draw any definite conclusions concerning the nature and source of the pseudo-enzyme. For example, we cannot say whether it is similar to, or derived from, the serum enzyme. It is certainly firmly attached to the cells, since it cannot be easily washed off. All the experiments quoted were done on pooled erythrocytes of male rats; hence the presence of this enzyme in female red cells has yet to be established. The precise type of pseudo-cholinesterase, too, is a matter for speculation. The almost complete lack of activity towards benzoylcholine makes it most unlikely that it is a benzoylcholinesterase[7], and the low propionylcholine to acetylcholine ratio of 0·8 would appear to rule out the possibility of a propiono-cholinesterase such as that found in rat heart[8], and which has a corresponding value of approximately 2·3. On the basis of its substrate ratio, it is possible that it may be a butyro-cholinesterase.

D. R. DAVIES
J. P. RUTLAND

Chemical Defence Experimental Establishment
(Ministry of Supply),
Porton, Salisbury.
May 3.

[1] Mundell, D. B., *Nature*, **153**, 557 (1944). Ellis, S., Sanders, S., and Bodansky, O., *J. Pharmacol.*, **91**, 225 (1947). Levine, M. G., and Suran, A. A., *Enzymologia*, **15**, 17 (1951).
[2] Mendell, B., Mundell, D. B., and Rudney, H., *Biochem. J.*, **37**, 473 (1943).
[3] Adams, D. H., *Biochim. Biophys. Acta*, **3**, 1 (1949).
[4] Fraser, P. J., thesis, University of Birmingham (1951), and private communication (1956).
[5] Aldridge, W. N., *Biochem. J.*, **53**, 62 (1953). Austin, L., and Berry, W. K., *Biochem. J.*, **54**, 695 (1953).
[6] Bayliss, B. J., and Todrick, A., *Biochem. J.*, **62**, 62 (1956).
[7] Sawyer, C. H., *Science*, **101**, 385 (1945).
[8] Ord, M. G., and Thompson, R. H. S., *Biochem. J.*, **49**, 191 (1951).

Receptor Occupancy and Tissue Response

ONE of the cornerstones of all quantitative applications of classical receptor theory has been the postulate that the response of a given organ or tissue is proportional to the number of receptors occupied by the activating agent, and that the maximal response occurs when all receptors are occupied. Although never proved experimentally, and perhaps *a priori* somewhat unlikely in view of the complex nature of tissue responses, this relationship is necessary if agonist dose – response curves are to be explained in terms of mass-action equilibria, and it provides the basis for differentiating reversible competitive from non-competitive or irreversible inhibition. Basic formulations applying mass-action considerations to the differentiation of types of inhibition are those of Gaddum[1], applied largely to tissue and organ responses, and of Linweaver and Burke[2], which have been applied both to relatively simple enzyme systems and to complex responses of tissues and of intact animals.

In general, use of the Linweaver–Burke equations to evaluate data obtained from studies on enzyme systems has proved satisfactory. However, some fundamental error in the application of these equations to data obtained from experiments on intact animals or isolated tissues is suggested by reports which classify the β-haloalkylamines (dibenamine congeners) as reversible competitive blocking agents on this basis[3]. Except at high concentrations of the inhibitor, data for the blockade of responses to adrenaline or histamine by these agents are typical of reversible competitive inhibition when plotted by either of the methods mentioned above. This observation conflicts with several lines of evidence which indicate that the blockade, although it is 'competitive' in the sense that the agonist and the antagonist react with the same receptors, is predominantly irreversible because of a stable bonding of the inhibitor to some tissue constituent in the area of the receptor[4].

Two types of experiments have been combined in the present study to provide a possible explanation for the above discrepancy. Isolated strips of guinea pig ileum were exposed to *GD*-121 (*SY*-14, *J*10; N-1-naphthylmethyl-N-ethyl-β-chloroethylamine) for 5 min., and the degree of blockade of the isotonic

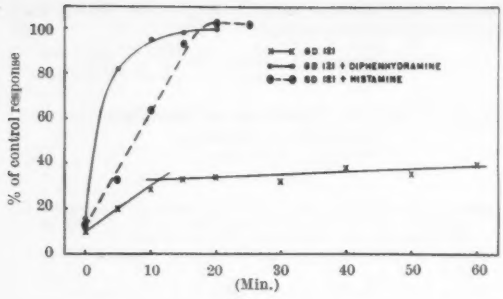


Fig. 1

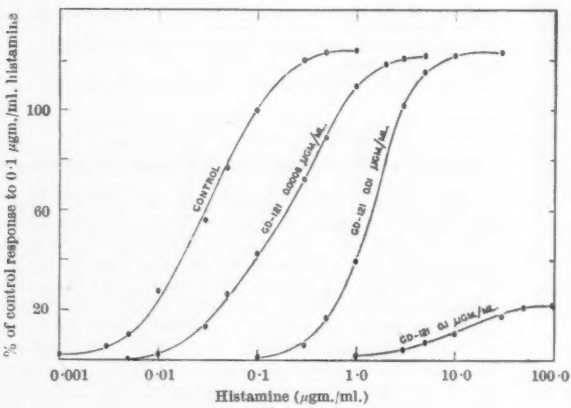


Fig. 2

response to a standard dose of histamine (0·1 μgm./ml.) was then determined in the presence of the inhibitor and after successive washes at 5- and 10-min. intervals. As shown in Fig. 1, a minor portion of the blockade was readily reversible; but the blockade remaining after 10 min. was essentially irreversible to washing. Some experiments were continued for as long as 8 hr. without a significant change in the slope of this line. As shown in the figure, histamine or diphenhydramine (benadryl) introduced prior to the *GD*-121 prevented the development of irreversible blockade, indicating that all three agents react with the same receptors. On the basis of these experiments, it may be concluded that in tissue treated with *GD*-121, a portion of the specific histamine receptors are inactivated essentially irreversibly, providing a relatively long period during which responses of a tissue with a reduced number of free receptors can be studied.

Histamine dose – response curves were then determined on untreated ileum and on segments exposed to varying concentrations of *GD*-121 and washed to remove blocking agent not irreversibly bound. The response of each preparation to a standard dose of 0·1 μgm./ml. of histamine prior to blockade was arbitrarily designated as 100 to facilitate compilation of results. In both figures, each point represents the average of six to ten separate determinations. It was found (Fig. 2) that the histamine dose – response curve could be shifted at least 2 log units along the agonist dose axis by low concentrations of *GD*-121 without changing either its slope or asymptote significantly[5]. Higher concentrations of *GD*-121 decreased both. These curves, except that on the extreme right, are characteristic of reversible competitive antagonism when plotted according to the equations of either Gaddum or Linweaver and Burke—an interpretation obviously incompatible with the results of the preceding experiments.

These observations can best be explained by assuming that receptor occupancy is not the limiting factor in the tissue activation, and that occupancy of only about 1 per cent of the histamine receptors is adequate to produce a maximal response. As the total number of free receptors is progressively decreased by irreversible combination with blocking agent, larger concentrations of agonist are required to provide the receptor occupancy necessary for any given response. Ultimately, the total number of free receptors is reduced below that required for a maximal response even when they are saturated by a very high concentration of agonist. This formulation explains why classical dose – response plots erroneously indicate reversible competitive antagonism at low, and irreversible or non-competitive antagonism at high, concentrations of a β-haloalkylamine. It does not necessarily imply that responses are not proportional to the number of receptors occupied over most of the response range. However, the evidence that receptor occupancy is not necessarily the limiting factor in determining the magnitude of a tissue response suggests that all theoretical deductions from mass-action analyses of dose – response curves should be accepted with caution.

This investigation was supported by grants-in-aid from the Canadian National Research Council and the Smith, Kline and French Laboratories.

Mark Nickerson

Faculty of Medicine,
University of Manitoba,
Winnipeg. June 28.

[1] Gaddum, J. H., *J. Physiol.*, **89**, 7*P* (1937).
[2] Linweaver, H., and Burke, D., *J. Amer. Chem. Soc.*, **56**, 658 (1934).
[3] Chen, G., and Russell, D., *Arch. Int. Pharmacodyn.*, **84**, 176 (1950). Chen, G., and Russell, D., *J. Pharmacol. and Exp. Therap.*, **99**, 401 (1950). Graham, J. D. P., and Lewis, G. P., *Brit. J. Pharmacol.*, **8**, 54 (1953).
[4] Nickerson, M., *Pharmacol. Rev.*, **1**, 27 (1949).
[5] Similar shifts of adrenaline and histamine dose – response curves have been reported to occur after exposure of tissues to dibenamine and *SY*-28 (N-1-naphthylmethyl-N-ethyl-β-bromoethylamine); see Furchgott, R. F., *Pharmacol. Rev.*, **7**, 183 (1955).

Ammonia Production in the Collecting Ducts of Mammalian Kidneys

Compared with other parts of the nephron, the cells of the collecting ducts are morphologically conspicuous by the absence of any particular differentiation. This has led to the assumption that their function is exclusively mechanical, that is, to convey the urine from the distal part of the nephron to the renal pelvis. Physiologists have not been able to assign any active cellular function to this part of the nephron, though Glimstedt[1] and Wirz[2] presented convincing evidence for its importance in water reabsorption and we have suggested[3] that back-diffusion of ammonia might occur in this segment. Both these functions are presumably of physico-chemical nature and independent of cellular activity.

In good agreement with this morphological and physiological undifferentiation are the results of biochemical investigations. Dickens and Weil-Malherbe[4]

Table 1

	Dog				Rabbit			
	No.	Cortex	Medulla		No.	Cortex	Medulla	
			Outer	Inner			Outer	Inner
Dry weight in % of wet weight	6	24	22	18	4	25	21	17
Glutaminase I*	6	1·86	0·35	0·52	4	0·08	0·04	0·13
Glutamine-α-keto acid transamination–deamidation system*	6	0·17	0·06	0	4	0·01	0·02	0
Glutamine synthesis†	6	0·04	0·01	0	4	0·09	0·01	0
Weight in % of kidney	3			15	4			11
Total glutaminase I/animal in μM ammonia/minute	3			66	4			0·21
Maximal ammonia excretion in μM ammonia/minute‡	6	50–75			7	0·08–0·35		

* In μM ammonia liberated by 100 mgm. wet weight per minute
† In μM ammonia taken up by 100 mgm. wet weight per minute
‡ In acute metabolic acidosis following infusion of 0·1 *N* hydrochloric acid

showed that renal medulla is one of the few adult mammalian tissues having a high aerobic glycolysis. Weil and Jennings[5], using the Linderstrøm-Lang technique, provided evidence that the collecting ducts are almost devoid of cathepsin, dipeptidase, amino polypeptidase, esterase and amylase. Histochemical studies have indicated the lack of active SH-groups, glycerophosphate dehydrogenase, adenosine triphosphatase, glucose-6-phosphatase, alkaline and acid phosphatase, lipase, esterase and succinic dehydrogenase in the lower part of the collecting ducts[6]. These studies, especially the observation of high glycolysis, indicate a low level of biochemical differentiation.

During investigations of the ammonia excretion in different mammalian species[3], it was observed that under different experimental conditions ammonia excretion correlated particularly well with glutaminase I activity of the kidney. To localize this enzyme, kidneys of different species were dissected into cortex, outer medulla and inner medulla and each part analysed using histological and biochemical methods. In this report the results of the analyses of two species, dog and rabbit, as representatives of animals with very high and very low ammonia excretion are presented (Table 1).

Determination of the dry weight of the different parts of the kidney showed marked differences, the cortex giving the highest, the papilla the lowest values. Such an analysis makes it very simple to check the quality of the dissection. The activities of glutaminase I [7], the transamination–deamidation system[7] and glutamine synthesis[7] were measured in homogenates of different parts of the kidney under optimal conditions[8].

Glutamine synthesis from glutamic acid, ammonia and adenosine triphosphate in the presence of magnesium and at a *p*H of 7·5 was found to be largely a function of the cortex. The renal transamination–deamidation system which liberates ammonia from glutamine in the presence of α-keto acids is optimal at *p*H 8·8. This enzyme system was localized primarily in the cortex of the dog and in the outer medulla and cortex of the rabbit. It may well be that these two systems participate in the process of amino-acid reabsorption.

Glutaminase I, a phosphate-activated enzyme with an optimal *p*H of 7·5, was observed in all parts of the kidney, though most of the activity was present either in the cortex or the papilla. The concentration of the enzyme in the inner medulla was conspicuous, since histological examination revealed only collecting and papillary ducts in these samples. It is therefore highly probable that enzymatic ammonia production occurs in this part of the nephron.

The total amount of papillary glutaminase I activity of the examined species was calculated by multiplying the weight of the inner medulla or papilla by the enzyme activity in a number of animals. As shown in Table 1 the total enzyme activity of this particular renal segment, containing exclusively collecting and papillary ducts, is sufficient to account for the maximal ammonia excretion observed in these species under acid stimulation. Various other correlations were tried, such as the total glutaminase I activity and the difference between glutaminase I activity and glutamine synthesis, but there was poor correlation with *in vivo* ammonia excretion.

It is well known that enzyme concentration is rarely a limiting factor for *in vivo* activity of biocatalytic systems; but, on the other hand, substrate or co-factor availability, intracellular *p*H and activators or inhibitors determine the rates of *in vitro* biochemical reactions[9]. Our observations seem to indicate that in ammonia excretion under maximal stimulation enzyme concentration may become limiting. This particular system offers the opportunity for the study of biocatalytic rate limitation by enzyme concentration.

These comparative enzymological and physiological studies suggest that enzymatic ammonia production for excretion in the mammalian kidney is a function of the collecting duct system. This was suggested by the micropuncture studies of Walker[10] in the frog, where the highest ammonia concentrations were found in the collecting ducts and ureters. Corroborative evidence is also supplied by clinical studies. Albright *et al.*[11] observed a patient with severe calcification of the renal pyramids who had deficient ammonia and acid secretion. The same metabolic defect was reported by Baines *et al.*[12] in a patient with extensive calcification of the pelvis and the pyramids but histologically intact tubular cells.

Since hydrogen ion secretion is probably a function of the distal tubule[13], a separate anatomical localization of these two important mechanisms of acid secretion is highly probable and may explain th dissociation of these two tubular functions observed under certain pathological conditions. Oliveira[14] found a normal ammonia excretion but defective hydrogen-ion production in two patients with tubular necrosis. The same defect is frequently observed in

the de Toni–Fanconi syndrome[15]. The opposite defect, normal acid excretion but impaired ammonia secretion, has been reported to occur in another renal disease of children with organic aciduria, hydrophthalmos, mental retardation and symptomatic rickets[16].

This work was supported by a grant *RG*-3795 from the National Institutes of Health, United States Public Health Service.

R. Richterich-van Baerle
Leon Goldstein
Earl H. Dearborn
Department of Pharmacology,
Boston University School of Medicine,
Boston, Massachusetts.
July 24.

[1] Glimstedt, G., *Nord. Med.*, **12**, 2924 (1941).
[2] Wirz, H., Hargity, B., and Kuhn, W., *Helv. Physiol. Acta*, **9**, 196 (1951).
[3] Richterich-van Baerle, R., Goldstein, L., and Dearborn, Earl H., *Science*, **124**, 74 (1956).
[4] Dickens, F., and Weil-Malherbe, H., *Biochem. J.*, **30**, 659 (1936).
[5] Weil, L., and Jennings, R. K., *J. Biol. Chem.*, **139**, 421 (1941).
[6] Wachstein, M., *J. Histo. and Cytochem.*, **3**, 246 (1955).
[7] Meister, A., *Physiol. Rev.*, **36**, 103 (1956).
[8] Richterich-van Baerle, R., Goldstein, L., and Dearborn, Earl H., *Enzymologia* (submitted for publication).
[9] Krebs, H. A., *Deutsche Med. Wchnschr.*, **81**, 4 (1956).
[10] Walker, A. M., *Amer. J. Physiol.*, **131**, 187 (1940).
[11] Albright, F., *et al.*, *Bull. Johns Hopkins Hosp.*, **66**, 7 (1940).
[12] Baines, G. H., Barclay, J. A., and Cooke, W. T., *Quart. J. Exp. Med.*, **14**, 113 (1945).
[13] Montgomery, H., and Pierce, J. A., *Amer. J. Physiol.*, **118**, 144 (1937).
[14] Oliveira, H. L. de, *Metabolism*, **2**, 37 (1953).
[15] Fanconi, G., *Helv. Paediat. Acta*, **1**, 133 (1946).
[16] Lowe, C. U., Terrey, M., and MacLachlan, E. A., *Amer. J. Dis. Child.*, **83**, 164 (1952).

Catalase Production by Lactobacilli

Lactobacilli are considered to be catalase-negative[1], or occasionally to produce very small amounts of catalase[2]. The lactobacilli isolated from dairy products have always been found to be catalase-negative[3,4]. During recent work on the microflora of Cheddar cheese, we have encountered strains of lactobacilli which possess both strong and weak catalase activity. Three strains of *Lactobacillus plantarum*, originally isolated by Sherwood[3] from New Zealand Cheddar cheese, were found to be catalase-positive. Two of the strains gave strong catalase reactions whereas the other strain was much weaker (see Table 1). Serological[5] and physiological[6] tests have shown that these latter organisms are typical strains of *L. plantarum*.

Production of catalase was detected by streaking the cultures on to the following agar media: (1) tomato juice, dextrose of Briggs[7]; (2) lactose, yeast, phosphate of Hunter[8]; and (3) yeast, tryptone, glucose of Felton, Evans and Niven[9]. The plates were incubated anaerobically at 30° for two or three days, and then either flooded with 5 ml. of a 3 per cent hydrogen peroxide solution (10 vol.) or the growth was washed off with 0·5 ml. of sterile distilled water and 0·5 ml. peroxide added, and then observed for the appearance of oxygen evolution. The effect of composition of the medium upon the production of catalase by the three strains of *L. plantarum* is shown in Table 1.

Table 1. Catalase Production by Lactobacilli on Different Media

Strain No.	Medium 1 (2 per cent glucose)	Medium 2 (2 per cent lactose)	Medium 2 (0·5 per cent glucose)	Medium 3 (0·05 per cent glucose)
1·1	++	++	+++	+++
3·1	–	–	+	+
4·3	+	++	+++	+++
Control plates (uninoculated)	–	–	–	–
Staph. aureus A 227				++++

Catalase production was much increased when the strains were grown on a medium with a low glucose content, as Felton, Evans and Niven[9] found also with the *Pediococci*.

J. C. Dacre*
Dairy Research Institute (N.Z.),
Massey Agricultural College,
Palmerston North, New Zealand.
M. Elisabeth Sharpe
National Institute for Research in Dairying,
University of Reading.
May 16.

* Present address: Toxicology Research Department, Medical School, University of Otago, Dunedin, New Zealand.

[1] Bergey's "Manual of Determinative Bacteriology", 6th edit. (Baillière, Tindall and Cox, London, 1948). Skerman, V. B. D., *Bact. Rev.*, **13**, 175 (1949).
[2] Topley and Wilson's "Principles of Bacteriology and Immunity", 3rd edit. (Arnold, London, 1946).
[3] Sherwood, I. R., *J. Dairy Res.*, **10**, 426 (1939).
[4] Orla-Jensen, S., "The Lactic Acid Bacteria", 2nd edit. (Munksgaard, Copenhagen, 1942). Davis, J. G., "A Dictionary of Dairying" (Leonard Hill, London, 1950).
[5] Sharpe, M. E., *J. Gen. Microbiol.*, **12**, 107 (1955).
[6] Wheater, D. M., *J. Gen. Microbiol.*, **12**, 133 (1955).
[7] Briggs, M., *J. Dairy Res.*, **20**, 36 (1953).
[8] Hunter, G. J. E., *J. Dairy Res.*, **14**, 283 (1946).
[9] Felton, E. A., Evans, J. B., and Niven, C. F., *J. Bact.*, **65**, 481 (1953).

Staining Properties of the Golgi Zone of the Shell Gland of the Dogfish

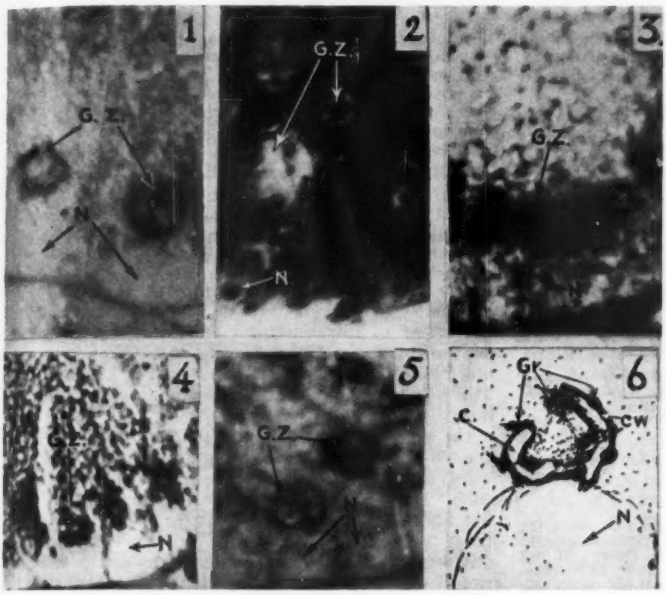
During research on the histochemistry of the shell gland of the dogfish, *Scyliorhinus caniculus*, some interesting reactions of the Golgi zone of the secretory cells have been observed.

In such material prepared according to Aoyama's silver technique, an oval or horse-shoe-shaped structure, either solid or with an argentophil exterior and an argentophobe interior, was visible in the Golgi zone (Fig. 1). In sections fixed in Regaud's fluid and afterwards postchromed, the secretory granules stained intensely with Heidenhain's hæmatoxylin, and an unstained circular or horse-shoe-shaped area was present in the Golgi zone above the nucleus (Fig. 2). Sections prepared in a similar manner and stained with sudan black showed a well-marked but diffuse zone without structural detail (Fig. 3).

In sections of the gland fixed in Bouin's fluid and stained with aniline blue (dilute, in 90 per cent alcohol) two diverse results were obtained. In some of the secretory cells a number of solid blue granules, in size and appearance similar to the secretory granules contained within these cells, were localized in the Golgi region (Fig. 4). In other instances, however, such localized granules were absent, and in their place a diffuse zone similar to that shown by sudan black was clearly visible.

Finally, it was observed that gland tissue fixed in 70 per cent alcohol and afterwards stained with aniline blue in 90 per cent alcohol, after treatment with catechol[2], also demonstrated the presence of a

Golgi zone throughout the gland. This zone consisted of a circular or horse-shoe-shaped unstained canal (*c*, Fig. 6), with blue-stained walls (*c.w.*, Fig. 6), in contact with which were a number of dark blue granules (*g.r.*, Fig. 6).



(1), (2) and (5), × 1,200. (3) and (4), × 400. (6) Diagrammatic drawing of Golgi zone in Fig. 5.
G.Z., Golgi zone; *N*, nucleus; *c*, Golgi canal; *c.w.*, Golgi canal walls; *g.r.*, granules in contact with the Golgi canal walls

Of the above observations the most interesting is the constant staining, as opposed to metallic impregnation, of the Golgi zone with aniline blue, after treatment, either of whole tissues or sections, with catechol. That the resulting appearance of the Golgi region after such staining is identical with that revealed by the silver technique is surely not without significance, and lends support to the classical view of the morphology of this cell organoid. The constituent parts of the Golgi zone of these secretory cells, that is, the blue-stained walls bounding the unstained vacuoles, would appear to correspond respectively to the areas of double membranes and of vacuoles which have been shown by electron microscope studies to make up the Golgi region of other cells[1]. At present the action of the catechol in this technique is not understood; but it seems reasonable to assume that it acts on the protein part of the Golgi region, either as a mordant or by unmasking it so that it becomes 'stainable'.

Further research, with the object of standardizing this technique in its application to both invertebrate and vertebrate cells, is continuing, and it is hoped that the results will be published elsewhere.

I wish to thank Prof. R. A. R. Gresson for help and advice during this work.

L. T. Threadgold

Department of Zoology,
The Queen's University,
Belfast. March 26.

[1] Gatenby, J. B., *La Cellule*, **57**, 243 (1955).
[2] Smyth, J. D., *Quart. J. Micro. Sci.*, **95**, 139 (1954).

A Toxic Lipid from the Surface of *Corynebacterium ovis*

We have been studying the pathogenic properties of *Corynebacterium ovis*, a diphtheroid bacillus which causes the well-known and widespread disease of sheep known as caseous lymphadenitis. Natural infection takes the form of an initial suppurative inflammation of skin wounds. This is followed in about 20 per cent of cases by chronic metastatic abscesses in the regional lymph nodes. In most cases the infection in sheep does not progress any further; but occasionally *C. ovis* escapes from lymph node lesions to give rise to further abscess formation in lungs, spleen, liver and other visceral organs. The guinea pig is readily infected experimentally, but in contrast to the sheep is far less resistant to progressive extension of these pyogenic lesions and dies in eight to twelve weeks with abscesses in various internal organs.

When grown in liquid media, *C. ovis* produces an exotoxin possessing hæmolytic and lethal properties for the sheep, guinea pig and rabbit, the *LD*50 for guinea pigs of 250 gm. by subcutaneous injection being of the order of 0·1–0·005 ml. The exotoxin, or its formol-toxoid, is a good antigen, eliciting the production of a specific antitoxin which readily neutralizes toxin *in vivo* and *in vitro*.

In contrast with *C. diphtheriae*, in natural infection by *C. ovis* there is no evidence of acute intoxication, and antitoxin appears to play little or no part in protecting against infection. The great majority of experimental animals, both guinea pigs and sheep, in which high levels of antitoxin have been induced either actively or passively, are still readily infected with very small doses of live organisms (for example, 15 bacilli in guinea pigs by subcutaneous inoculation).

Phagocytosis of *C. ovis* by leucocytes of both sheep and guinea pigs occurs rapidly *in vivo* and *in vitro*. Leucocytes which have engulfed small numbers of *C. ovis* and are then maintained under tissue culture conditions undergo rapid degeneration and die.

In seeking the mechanism of this injurious action of engulfed organisms on leucocytes, we have found that a light extraction of live *C. ovis* with petrol ether removes a lipid without impairing the viability of the organism on ordinary culture media. This lipid extract is a wax-like substance with interesting toxic properties. It is insoluble in water; but when dissolved in either liquid paraffin or sterile guinea pig fat and injected intradermally in guinea pigs or rabbits, it produces a marked reaction characterized by swelling, congestion and, at the higher dose-rates, a central zone of hæmorrhagic necrosis which afterwards sloughs out. This reaction is not influenced by prior inoculation of the guinea pig with large doses of antitoxin, which specifically neutralizes exotoxin. We have also found that this lipid, dissolved in either liquid paraffin or sterile guinea pig fat, or absorbed on small particles of activated charcoal, when phago-

cyted by leucocytes, is followed by characteristic degenerative changes and death of the latter. On the other hand, doses of up to 500 mgm. of lipid in liquid paraffin inoculated intraperitoneally in guinea pigs produced no evidence of general systemic toxic effects.

There are obvious similarities between this toxic lipid of *C. ovis* and the surface lipoid component ('cord factor') of the virulent tubercle bacillus recently reported by Bloch and others[1], which, in addition to having toxic properties, appears to be closely concerned with the mechanism of the immunological response to the tubercle bacillus[2]. In contrast with the reported toxicity of 'cord factor', which produces death with pulmonary hæmorrhages in mice two to three weeks after intraperitoneal injection, *C. ovis* lipid has a local toxic action which appears within twenty-four hours after intradermal injection, leucocytes are especially vulnerable and no delayed systemic toxic effects have been observed in guinea pigs.

A detailed account of this work, including chemical and immunological studies at present in progress, will be published elsewhere.

H. R. Carne
Nancy Wickham
Joan C. Kater
Department of Veterinary Pathology
and Bacteriology,
University of Sydney.

[1] Bloch, H., *J. Exp. Med.*, **91**, 197 (1950). Asselineau, J., Bloch, H., and Lederer, E., *Amer. Rev. Tuberc.*, **67**, 853 (1953). Bloch, H., Sorkin, E., and Erlenmeyer, H., *Amer. Rev. Tuberc.*, **67**, 329 (1953). Bloch, H., and Noll, H., *Brit. J. Exp. Path.*, **36**, 8 (1955).
[2] Suter, E., and White, R. G., *Amer. Rev. Tuberc.*, **70**, 793 (1954). White, R. G., Coons, A. H., and Connolly, J. M., *J. Exp. Med.*, **102**, 83 (1955).

Occurrence of New *Salmonella* Types from South Africa

Upon bacteriological examination of day-old chicks imported by air from the Union of South Africa and found dead on arrival at Elizabethville, the following types of *Salmonella* were detected by culturing the bone marrow of fourteen of them on the usual media: 2 strains of *S. saint paul* (4,5,12 : *e,h* : 1,2); 1 strain of *S. vejle* (3,10 : *e,h* : 1,2); 1 strain of *Salmonella* unidentified, probably *S. newport* (6,8 : *e,h* : 1,2) rough.

Salmonella saint paul and *S. vejle* seem never to have been isolated in South Africa[1-3]. A few strains of *S. newport* have been isolated by Henning[2], one from a human being and another from a duck.

In the Belgian Congo, *S. saint paul* has only been isolated from human stools (7 strains)[4]. *S. vejle* has been isolated only once from a native child's stools[4]. *S. newport* is well known and has been isolated several times from human material and from horse and goat[5-7].

In East Africa, between 1948 and 1953, Mackey[8] isolated in Dar es Salaam 3 strains of *S. saint paul*, all from human origin; none of *S. vejle* and 11 strains of *S. newport* (9 from humans and 2 from lizards).

We might thus consider that *S. saint paul* and *S. vejle* are new for South Africa.

This is also their first isolation from animals in the Belgian Congo, and the fact that they were found in imported chickens is one more hint on the complex epizootology of salmonellosis in animals.

We acknowledge with gratitude the co-operation of Dr. Joan Taylor, director of the Salmonella Reference Laboratory, Colindale Avenue, London, to whom all these strains were sent for identification.

J. Deom
Veterinary Laboratory,
Elisabethville,
Belgian Congo.
March 23.

[1] Henning, M. W., *Onderstepoort J. Vet. Sci.*, **13**, 79 (1939).
[2] Henning, M. W., personal communication.
[3] Taylor, J., personal communication.
[4] van Oye, E., *Ann. Soc. Belge Méd. Trop.*, **35**, 229 (1955).
[5] van Oye, E., *Ann. Soc. Belge Méd. Trop.*, **32**, 179 (1952).
[6] van Oye, E., *Bull. Soc. Path. Exot.*, **46**, 340 (1953).
[7] Kauffmann, F., *Acta Path. Microbiol. Scand.*, **32**, 549 (1953).
[8] Mackey, J. P., *E. Afr. Med. J.*, **32**, 1 (1955).

Influence of Nutritional State on the Heat Tolerance of Cattle

On completion of an experiment in which two differently fed groups of cattle were used for studying the effect of low nutrition on seasonal changes in the hair coat, opportunity was also taken to make observations on the heat tolerance of the animals. The results of these latter observations are reported here.

On April 20, 1955, eight poll shorthorn heifers aged 6–8 months and weighing an average of 351 lb. were randomly divided into two groups of four animals each. One group, kept on clean straw bedding, was fed liberally, calf meal (18 per cent crude protein) being supplied at the rate of 2 lb. per animal per day together with as much lucerne hay as the animals would consume. On this ration, individuals of the group increased to an average of 672 lb. weight by February 28, 1956. The feed of the other group was restricted as necessary to maintain constant weight of the individuals over the same period. They were bedded on sawdust and received meal at the rate of 4 oz. per animal per day, one-quarter the amount of lucerne hay supplied to the well-fed group and less straw than sufficient to satisfy appetite. Both groups received vitamin supplement in the form of a commercial preparation of fish liver oil.

On February 28, 1956, immediately following their usual morning feed, the eight heifers were subjected to a heat tolerance test in a psychometric room. The duration of the test was three hours unless an animal's rectal temperature reached 107° F., in which case the individual was withdrawn. The room temperature during exposure was 105° F. dry bulb and 92° F. wet bulb. Rectal temperatures were taken at the end of each hour, and each animal's heat tolerance coefficient was calculated from its rectal temperature at the end of the test, using Rhoad's[1] formula:

$$\text{Heat tol. coeff.} = 100 - 10\,(\text{rect. temp.} - 101)$$

The mean heat tolerance coefficient of the fat, well-fed group was 43; that of the thin, poorly fed group 55. The difference of 12 between the group means is highly significant ($P = 0{\cdot}01$) and reflects the greater heat tolerance of the thin animals. This was also evidenced by their relative freedom from drooling, their calmer breathing and less anxious state at the end of the test.

Following this test, the poorly fed group was placed on the liberal ration, whereas no feed at all was allowed the well-nourished group. These feeding conditions obtained for the post-test period of February 28, for all of February 29 and for the morning of

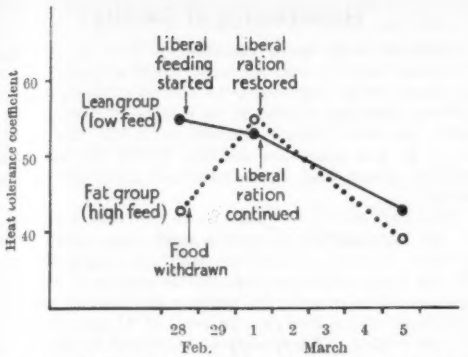


Fig. 1. Influence of the current rate of feeding on the heat tolerance of two groups of cattle reared on different planes of nutrition

March 1, when the heat-tolerance test was repeated. This time the heat tolerance of both groups was good and the difference between the mean of the fat group (55) and the mean of the thin group (53) was not statistically significant. The notable result was the 12-point improvement in heat tolerance of the fat animals.

After this test, both groups were placed on the liberal ration until a third heat-tolerance test was conducted four days later, on March 5. This time both groups showed poor heat tolerance. The mean heat-tolerance coefficients were 39 and 43 for the fat and thin groups, respectively, the difference not being statistically significant.

The results, presented graphically in Fig. 1, show that high condition is not in itself a disadvantage to cattle in withstanding heat. A high current rate of feeding, however, in either fat or poor cattle may, under hot conditions, add seriously to the heat load of the animals. This is similar to the conclusion reached for hens, sheep and pigs by Robinson and Lee[2], who also reported that the proportion of protein contained in the diet was without effect on the heat tolerance of these three species.

The present experiment also showed that, following change to the liberal ration, the heat tolerance of the under-nourished animals was still high two days after the change, but was low by the sixth day. The lag is probably a reflexion of the time required for the digestive tract of cattle to condition itself to assimilating and utilizing more and better feed, following a long period of restriction.

These results emphasize, *inter alia*, the importance of standard feeding routine when seasonal or other periodic heat tolerance tests are to be made.

The environmental studies of which this experiment forms a part are being conducted at the Physiology Department, University of Queensland, and, as an officer of the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, I am grateful to Prof. W. V. Macfarlane for his co-operation and help.

N. T. M. Yeates

Commonwealth Scientific and Industrial Research Organization, and Physiology Department, University of Queensland, Brisbane. May 8.

[1] Rhoad, O. A., *Trop. Agric., Trinidad*, 21, 162 (1944).
[2] Robinson, K. W., and Lee, D. H. K., *J. Anim. Sci.*, 6, 2, 182 (1947).

Identification of *Pseudomonas pyocyanea* by the Oxidase Reaction

Although the identification of *Pseudomonas pyocyanea* is generally very simple, the diagnosis of 'atypical' strains may take several days, and, as Schaub and Foley[1] stress, "its identification may present a problem". Yow and Townsend[2], in their study on the sensitivity of *Ps. pyocyanea* to various antibiotics, limit the scope of their examinations: "Because of the difficulty in positively identifying the non-pigment-producing strains of Pseudomonas, only those producing either pyocyanin, fluorescin, or both, were included in this study". However, apyocyanogenic strains are common. These strains are either primarily deficient in producing pigment or may have lost their ability to do so. Haynes[3] therefore points out: "Strains not producing pyocyanin, from whatever source, cannot be dismissed from consideration as Ps. pyocyanea."

Already Gordon and McLeod[4] have observed that *Ps. pyocyanea*, besides other bacteria, gives a positive oxidase reaction although much less markedly than the Neisserias.

I have increased the sensitivity of the oxidase reaction by the following technique. A piece of Whatman's No. 1 filter paper, about 6 cm. square, is laid in a Petri dish. Two to three drops of 1 per cent tetramethyl*para*phenylenediamine dihydrochloride solution is dropped on the centre of the paper. The suspect colony is removed with a platinum rod and is smeared thoroughly on to the reagent-impregnated filter paper in a line 3–6 mm. long. If the reaction is positive, the transferred colony turns dark purple in 5–10 sec. The reagent should be prepared every two weeks and kept in a dark, glass-stoppered dropping bottle in the refrigerator.

All 436 *Ps. pyocyanea* strains examined gave a positive oxidase reaction with the technique described, while the other common Gram-negative rods are oxidase negative. The oxidase reaction can be used as a simple, rapid screening test in the diagnosis of *Ps. pyocyanea*.

Detailed investigations on the confirmatory test for *Ps. pyocyanea* will be published elsewhere.

Nicholas Kovacs

Public Health Laboratories, Perth, Western Australia. May 1.

[1] Schaub, J. G., and Foley, M. K., "Diagnostic Bacteriology", 4th edit., 178 (1952).
[2] Yow, E. M., and Townsend, E. S., "Antibiotics and Chemotherapy", 3, 709 (1953).
[3] Haynes, W. C., *J. Gen. Microbiol.*, 5, 939 (1951).
[4] Gordon, J., and McLeod, J. W., *J. Path. and Bact.*, 31, 185 (1928).

Structure of the Ascidian *Octacnemus* Moseley

The tunicate family Octacnemidae contains two genera, *Octacnemus* Moseley and *Polyoctacnemus* Ihle, and four species, all from great oceanic depths. The species have been described by Moseley[1], Herdman[2], Metcalf[3], Ritter[4], and Madsen[5]; but their structure is peculiar and has never been satisfactorily related to that of other tunicates.

Octacnemus, the better-known genus, has in particular the following characters not found in

other tunicates: (1) a crown of eight large triangular lobes on the upper side, (2) an upper and a lower cavity between the test and the body proper, (3) a 'horizontal membrane' separating these two cavities and extending out into the eight lobes. The organs of the body are less peculiar; but the pharynx is much modified, having only a few imperforate branchial stigmata or none at all. The nature of the crown of lobes has never been satisfactorily explained, and the upper and lower cavities between the test and the body have generally been taken to represent the expanded cavity of the oral siphon and the modified atrial cavity respectively (Ihle[6], Madsen[5], Brien[7]). Ritter[4], however, maintained that at least the upper cavity is an artefact.

I have recently been able to examine a single specimen of *Octacnemus bythius* Moseley, taken in 1952 by the Danish Deep Sea Expedition from 2,700 metres in the Kermadec Deep. The specimen showed the well-known features of the species; but dissection revealed the presence of a true atrial cavity agreeing in position with that of unmodified ascidians—that is, dorsal to the pharynx—although in *Octacnemus* it is too small to envelop the sides of the pharynx. The partition between the atrial cavity and the pharynx is perforated by a few small openings, but it is uncertain if these represent modified branchial stigmata. There is a short tubular atrial siphon, the outer end of which has been torn away from the test. The atrial siphon is evidently the structure described and illustrated by Moseley as the rectum; the true rectum opens within the base of the atrial siphon as in other ascidians.

The crown of eight lobes and the corresponding prolongations of the 'horizontal membrane' represent, with little doubt, the greatly developed lobes of the oral siphon. The position of the lobes around the opening to the pharynx, their number, the relation of their circular and longitudinal muscles, and the presence of test on both faces of the lobes all point to this conclusion. The 'horizontal membrane' is simply the expanded and opened-out base of the oral siphon.

The Octacnemidae are therefore true, although much modified, ascidians, since the crown and 'horizontal membrane' are the enlarged oral siphon, a true atrial cavity and atrial siphon exist, and the upper and lower cavities between test and body may be artefacts produced at death. The number of oral lobes and the arrangement of the gonads indicate that the family belongs to the sub-class Enterogona, probably having been evolved from an ancestral form rather like *Ciona*.

A fuller account of this work is being published elsewhere.

R. H. Millar

Marine Station,
Millport,
Isle of Cumbrae,
Scotland.
May 23.

[1] Moseley, H. N., *Trans. Linn. Soc. Lond.*, 1, 287 (1877).
[2] Herdman, W. A., Challenger Rep., Zool., 27 (1888).
[3] Metcalf, M. M., *Zool. Jahrb.*, 13, 495 (1900).
[4] Ritter, W. E., *Bull. Mus. Comp. Zool., Harv.*, 46, 231 (1906).
[5] Madsen, F. J., *Vidensk. Medd. dansk. naturh. Foren. Kbh.*, 110, 31 (1947).
[6] Ihle, J. E. W., "Hand. Zool.", 5 (1935).
[7] Brien, P., "Traité de Zool." (Grassé), 11 (1948).

Hand-rearing of Rabbits

Rabbits that were completely free of coccidial infection were desired for experimental purposes. It appeared to be impossible to obtain such rabbits by normal breeding methods, as infection, usually very mild, occurred during contact with the doe in the nest. It was therefore decided to try to hand-rear rabbits which had been removed from the doe at birth.

The expression of milk from the doe was found to be impractical, so cow's milk was used. The protein content of rabbit milk is approximately 10 per cent, whereas that of the cow is 4 per cent, and therefore in order to increase the protein, calcium caseinate was added at the level of 15 gm. to 10 oz. of cow's milk. After several attempts it was found that this mixture could be used until the animals were seven days old, when it was necessary to increase the amount of calcium caseinate to 17 gm. for 10 oz. cow's milk and at fourteen days old the level of calcium caseinate was further increased to 20 gm. This level was maintained until the young rabbits were able to eat fresh green food when about four weeks old, at which time they were weaned. Fig. 1 shows the weight curves for the hand-reared animals and their litter mates still with the doe.

The calcium caseinate did not dissolve freely in the cow's milk unless the whole was beaten with an egg whisk. This mixture would keep for several days in a refrigerator. The milk mixture was warmed by placing it in the feeding bottles and immersing them in a cup containing warm water.

As delivery of the milk was not satisfactory with a pipette, feeding bottles with rubber teats as used for dolls were obtained. After making a hole in the end of the teat, the only difficulty encountered was the over-anxiousness of the young rabbit to obtain its milk; and a little practice was necessary in order to insert the teat satisfactorily between the tongue and upper jaw of the animal. The rapidity with which the milk was consumed did not appear to affect the animal adversely. Sufficient was judged to have been given when the rabbit would take no more, despite a rest of a few minutes.

The feeds were given approximately every three hours, the last feed being at midnight and the first

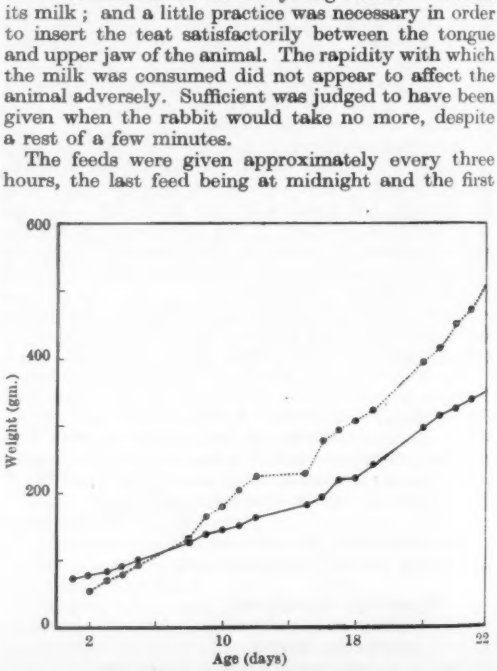


Fig. 1. ●—●—, Hand-reared; ○– – ○– –, naturally reared

at 5–6 a.m. The animals were transported in a box lined with hay and cotton-wool and care was taken to ensure that they were at all times kept warm.

One danger that was met was the accidental inhalation of some of the milk, which caused a fatal pneumonia. Another hazard was an enteritis which was successfully treated with intramuscular injections of chloramphenicol.

DORIS M. HILLS
I. MACDONALD

Animal House and Department of Physiology,
Guy's Hospital Medical School,
London, S.E.1.
May 23.

Insecticide Resistance in *Anopheles gambiae* Giles

THE appearance of *Anopheles gambiae* resistant to dieldrin only eighteen months after this insecticide was first used in a malaria control pilot project in Northern Nigeria has recently been reported[1]. It was calculated to be some eight times as resistant as a susceptible strain of the same species maintained at the Ross Institute of Tropical Hygiene, London[2].

Through the courtesy of Dr. L. J. Bruce-Chwatt, malariologist, Government of Nigeria, eggs of the resistant *A. gambiae* were dispatched to the Ross Institute, and this strain has now been successfully colonized. This successful dispatch of viable eggs from such an out-of-the-way part of Africa was in itself a major achievement. Colonization proved a relatively simple matter, in fact much more simple than the colonization of a susceptible strain of the same species from Lagos. This latter colony was started in 1951 and has been maintained in London ever since[3].

The two strains of the same species have now been compared for their susceptibilities to a range of insecticides using the technique described by Busvine in an annex to the Fifth Report of the World Health Organization Expert Committee on Malaria[4]. This technique involves the exposure of mosquitoes to filter paper impregnated with various concentrations of insecticides in Risella oil for 1 hr. and recording mortalities 24 hr. later. Table 1 records the median lethal concentrations of various insecticides after this 1-hr. exposure. The resistant strain was so highly resistant to dieldrin and aldrin that even 4 per cent solutions of these insecticides (a percentage nearing saturation in the case of dieldrin) failed to give any kill after exposure for 1 hr. This strain was, however, susceptible to DDT, pyrethrins and malathion. The slight difference in median lethal concentration of

Table 1. Median lethal concentrations (percentages in Risella oil or olive oil) of various insecticides when susceptible and resistant strains of *Anopheles gambiae* are exposed for one hour. (Numbers of female mosquitoes tested at concentrations giving more than 0 and less than 100 per cent mortalities are given in brackets)

Insecticide	Lagos strain (susceptible)	Ambursa strain (resistant)
Pyrethrins	0·4 (138)	0·8 (302)
DDT	0·6 (201)	0·6 (97)
Malathion*	0·8 (60)	1·4 (50)
Gamma-BHC	0·007 (177)	0·18 (62)
Dieldrin	0·08 (831)	no kill at 4 per cent
Aldrin	0·2 (142)	no kill at 4 per cent

* In solution in olive oil.

Table 2. Percentage mortalities among susceptible and resistant *Anopheles gambiae* exposed for 5 hr. to various concentrations of insecticides. (Numbers of female mosquitoes tested are given in brackets)

Percentage concentration of insecticide in Risella oil	Dieldrin	Aldrin	Isodrin	Endrin	Alpha-chlordane	Beta-chlordane
			Susceptible strain			
0·001	4 (50)	6 (36)				
0·01	81 (52)	15 (33)	32 (63)	14 (43)		
0·05			64 (47)	64 (44)		
Check	5 (20)	0 (16)	8 (39)	8 (39)		
			Resistant strain			
2·0			11 (19)	5 (21)		
4·0	10 (70)	2 (57)	65 (82)	76 (80)	0 (21)	
5·0						0 (22)
8·0			79 (42)			
10·0					0 (20)	
Check	0 (46)	0 (16)	3 (76)	3 (76)	0 (24)	0 (24)

the two latter insecticides for the two strains is thought merely to be a reflexion of the difference in size and vigour generally of the resistant strain. The Northern Nigeria strain was some twenty-six times as resistant to gamma-BHC as the Lagos strain.

To ascertain the degree of resistance to other insecticides, the exposure time had to be increased, and this necessitated decreases in concentrations for the susceptible strain. Table 2 summarizes mortalities 24 hr. after 5-hr. exposures to dieldrin, aldrin, isodrin, endrin, alpha-chlordane and beta-chlordane and shows the resistant strain to be some 140 times as resistant to isodrin and some 90 times to endrin as the Lagos strain. These results also show the resistant strain to be at least 400 times as resistant to dieldrin; but kills with the other three insecticides were still too small to indicate the degrees of resistance.

Exposures of 18 hr. were then resorted to, but this brought in the complication of check mortalities; these were eventually reduced to almost zero by exposing the mosquitoes in open-ended tubes, the ends being covered with mosquito netting. Table 3 compares the mortalities after 18-hr. exposures of the susceptible and resistant strains to dieldrin, aldrin, alpha-chlordane and beta-chlordane. The resistant strain is some 800 times as resistant to dieldrin and some 400 times to aldrin. Kills were again too low with alpha- and beta-chlordane to assess the degrees of resistance, which must be more than 1,000 in the case of alpha- and more than 500 in the case of beta-chlordane.

These results show a remarkably high degree of resistance to dieldrin and related compounds in the Northern Nigeria strain, a degree much higher than that recorded on the spot[1]. It is suggested that in the

Table 3. Percentage mortalities among susceptible and resistant *Anopheles gambiae* exposed for 18 hr. to various concentrations of insecticides. (Numbers of female mosquitoes tested are given in brackets)

Percentage concentration of insecticide in Risella oil	Dieldrin	Aldrin	Alpha-chlordane	Beta-chlordane
		Susceptible strain		
0·001	24 (104)	14 (59)	37 (59)	24 (82)
0·005	65 (61)			
0·01	98 (63)	24 (25)	40 (62)	55 (84)
Check	3 (93)	1 (72)	7 (68)	7 (88)
		Resistant strain		
4·0	70 (140)	24 (131)	0 (21)	
5·0				8 (131)
10·0			19 (119)	
Check	7 (97)	7 (98)	7 (122)	7 (122)

susceptibility tests made in Nigeria itself a mixed population of susceptible and resistant mosquitoes was used. This is borne out by the fact that significant kills were produced by an exposure of only 1 hr. to dosages of dieldrin considerably less than 4 per cent, even as low as 0·5 per cent. The eggs sent on three separate occasions to London may also have been mixed susceptible and resistant strains; but only a small percentage survived the journey. It is suggested that these were the highly resistant individuals; in other words, the journey by air has resulted in a selection of only the most vigorous mosquitoes, which are at the same time the ones highly resistant to insecticides.

Cross-resistance to the related chlorinated hydrocarbons, aldrin, alpha- and beta-chlordane, isodrin, endrin and gamma-BHC, has previously been commented on by Busvine[5] and Metcalf[6]. Busvine places these insecticides in the following order from the degrees of resistance shown by houseflies: alpha-chlordane (highest), beta-chlordane, aldrin, dieldrin, gamma-BHC, isodrin and endrin (lowest). With the resistant *A. gambiae* the order would appear to be: alpha-chlordane (highest), beta-chlordane, dieldrin, aldrin, isodrin, endrin and gamma-BHC (lowest).

G. Davidson

Ross Institute of Tropical Hygiene,
Keppel Street,
London, W.C.1.

[1] Elliott, R., and Ramakrishna, V., *Nature*, 177, 532 (1956).
[2] Busvine, J. R., *Nature*, 177, 534 (1956).
[3] Wall, W. J., *Trans. Roy. Soc. Trop. Med. Hyg.*, 47, 268 (1953).
[4] World Health Organization Tech. Series Report No. 80 (1954).
[5] Busvine, J. R., *Nature*, 174, 783 (1954).
[6] Metcalf, R. L., *Physiol. Rev.*, 35, 197 (1955).

A High Frequency of Heterozygous Diploids and Somatic Recombination produced by Ultra-violet Light in Imperfect Fungi

Pontecorvo and his co-workers[1] have demonstrated that, by the use of appropriate selection techniques, heterozygous diploids can be secured from heterocaryons of *Aspergillus nidulans*. Further, these diploids produced, on cultivation, recombinants by both somatic crossing-over[2] and somatic reduction. Later, similar results were obtained with the asexual strains, *Aspergillus niger*[3] and *Penicillium chrysogenum*[4]. I have succeeded in producing heterozygous diploids in the asexual fungi *A. sojae* and *A. oryzae* by the use of similar methods. These diploids also showed somatic segregation and yielded recombinations of the original genotypes. First-order segregations showed further segregation upon cultivation. Only a few segregants have been analysed and all proved to be still diploid in having double the haploid amount of deoxyribonucleic acid per nucleus. Their occurrence can be explained by the same type of somatic crossing-over as that discussed by Pontecorvo[5] and originally discovered by Stern[6].

The frequency of spontaneously arising somatic diploid nuclei in *A. sojae* is about 10^{-7}, or the same as that in *A. niger* and *A. nidulans*. In all three fungi, camphor increased this frequency to about 10^{-6}. It was further found that the frequency of heterozygous diploids in *A. sojae* could be raised to more than 10^{-2} by ultra-violet light.

When conidia of a heterocaryon between yellow-leucineless and albino-histidineless mutants of *A. sojae* were exposed to ultra-violet light until only about 1 per cent survived and were then plated on complete medium, 2–9 per cent of the survivors formed green colonies which were also prototrophic and diploid. Similar results were obtained with other heterocaryons and with one between yellow-methionineless and albino-leucineless mutants of *A. oryzae*. This great increase in diploidization was not simply due to the selective survival of diploid nuclei which were spontaneously present, as the relation between a survival of 10^{-2} and the increase from 10^{-7} to 10^{-2} in the frequency of diploids clearly shows; there was an absolute increase in the numbers of diploids.

Ultra-violet light was also active in stimulating somatic segregation in these diploids. When conidia from a green diploid colony were irradiated with different doses, there was a progressive decrease, from 9 to 75 per cent, in the green colonies formed upon plating. Correspondingly, there was an increase in the frequency of albino, yellow and sectored segregants. This phenomenon may be similar to that observed by James[7] with heterozygous diploid yeast.

The use of ultra-violet light to produce an extraordinarily high frequency of heterozygous diploids in asexual fungi should make feasible an analysis of their mode of origin and their subsequent behaviour, and should also greatly facilitate the production of new and improved strains for industrial use.

The results of this investigation will be published in detail and in English in the *Journal of General and Applied Microbiology*.

Chiyoko Ishitani

Division of Microbial Genetics,
Institute of Applied Microbiology,
University of Tokyo.
April 28.

[1] Pontecorvo, G., and Roper, J. A., "Advances in Genetics", 5, 218 (1953).
[2] Roper, J. A., and Pritchard, R. H., *Nature*, 175, 639 (1955).
[3] Pontecorvo, G., Roper, J. A., and Forbes, E., *J. Gen. Microbiol.*, 8, 198 (1953).
[4] Pontecorvo, G., and Sermonti G., *J. Gen. Microbiol.*, 11, 94 (1954). Sermonti, G., *Rend. Ist. Sup. Sanità*, 17, 231 (1954).
[5] Pontecorvo, G., *Caryologia*, Vol. Supp. 1 (1954).
[6] Stern, C., *Genetics*, 21, 624 (1936).
[7] James, A. P., *Genetics*, 40, 204, 826 (1955).

"Polyploidy in Bluebells"

J. Yanney Wilson has recently given an account of polyploidy in bluebells (*Endymion non-scriptus* and *E. hispanicus*)[1]. There are some errors in this paper which it is desirable to correct. The "extraordinarily large forms" to which reference is made have not been determined by me as hybrids. Apparently the author has misunderstood the excellent coloured figures in the *Botanical Magazine*, N.S., 176 (1952). The central figure is of *Endymion hispanicus*, the left-hand one is of *E. non-scriptus*, and the right-hand one is of the putative hybrid. Further, the impression is given that Mr. Yanney Wilson examined my material cytologically; but he has not done so and I have not had the opportunity of studying his plants taxonomically.

W. B. Turrill

Royal Botanic Gardens,
Kew.

[1] *Nature*, 178, 195 (1956).

FORTHCOMING EVENTS

(Meeting marked with an asterisk • is open to the public)

Monday, October 1

SOCIETY OF ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. K. J. Frost: "The Calder Hall Nuclear Power Station".

Tuesday, October 2

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. J. Harris: "Prestressed Concrete Runways: History, Practice and Theory".

Tuesday, October 2—Thursday, October 4

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Chemical Research Laboratory (at Teddington, Middlesex)—Open Days.

Tuesday, October 2—Wednesday, October 10

FUEL EFFICIENCY EXHIBITION (at Olympia, London, W.14).•

Wednesday, October 3

Technical Meetings to discuss "The Efficient Use of Fuel in Industry". (Further meetings on October 4, 9, and 10.)

Wednesday, October 3

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. B. Capdeville: "The Le Havre–Paris Pipeline".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "Chromatography". Mr. W. H. C. Shaw, Mr. J. P. Jefferies and Mr. T. E. Holt: "The Determination of Vitamin D and Related Compounds. Part I: Introduction and Preparation of Compounds in the Irradiation Series. Part II: Analysis of Irradiation Products"; Dr. A. S. Curry: "Some Examples of the Use of Paper Chromatography in Toxicological Analysis".

Thursday, October 4

BONE AND TOOTH SOCIETY (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Tissue Culture and the Induction of Bone and Connective Tissues". Prof. J. J. Pritchard: "Bone and Cartilage Induction in the Rabbit, Rat and Guinea Pig"; Lady May Mellanby and Mr. P. J. Holloway: "Tissue Culture as a Tool in Dental Research"; Dr. J. D. Biggers: "Studies in the Cultivation of Embryonic Bones in Chemically Defined Media"; Mrs. Shirley Hughes: "Experimental Embryology of Teeth".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Prof. W. R. Jones: "Mineral Resources". (First of a series of six lectures on "The Conservation of Natural Resources.")

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Sir Gordon Radley: Inaugural Address as President.

Friday, October 5

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Sir Charles Dodds, F.R.S.: "Application of Chemical Analysis to Medical Diagnosis and Treatment". (Chairman's Address.)

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (joint meeting with the MICROBIOLOGY GROUP, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Prof. A. Neuberger, F.R.S.: "Some Uses of Isotopes in Biochemistry".

Saturday, October 6

ASSOCIATION OF CLINICAL BIOCHEMISTS (joint meeting with the ASSOCIATION OF CLINICAL PATHOLOGISTS, at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 9.30 a.m.—Scientific Papers and a Symposium on "Biochemical Lesions: Keto-Acid Metabolism and the Citric Acid Cycle".

NUTRITION SOCIETY, and LABORATORY ANIMALS BUREAU (at Guy's Hospital Medical School, St. Thomas Street, London, S.E.1), at 10.40 a.m.—Joint Symposium on "The Nutrition of Laboratory Animals".

BRITISH INTERPLANETARY SOCIETY (in the York Hall, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Prof. H. S. W. Massey, F.R.S.: "The Study of the High Atmosphere in the International Geophysical Year".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B (with an honours degree in chemistry, and preferably experience in industry, teaching or research), to teach organic and inorganic chemistry—The Principal, Wigan and District Mining and Technical College, Wigan (October 5).

SENIOR LECTURER IN RADIOLOGY at University College, Ibadan, Nigeria—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (October 5).

ASSISTANT LECTURER (medically qualified) IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Liverpool (October 6).

CHAIR OF AGRICULTURE in the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 9).

LECTURER OR ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Hull (October 13).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (October 15).

LECTURER IN MECHANICAL ENGINEERING DESIGN—The Secretary of University Court, The University, Glasgow (October 17).

ASSISTANT LECTURER (with special interests in the field of historical geography) IN GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (October 20).

LECTURER IN (*a*) PHYSICAL GEOGRAPHY and (*b*) ECONOMIC GEOGRAPHY at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 20).

LECTURER IN PURE MATHEMATICS—The Secretary, Queen's University, Belfast (October 20).

LECTURER (with a degree or diploma or equivalent qualifications, and preferably previous lecturing experience) IN ZOOLOGY at the New South Wales University of Technology, Sydney, Australia—The Agent-General for New South Wales, 56 Strand, London, W.C.2; and The Bursar, New South Wales University of Technology, Box 1, Post Office, Kensington, N.S.W., Australia, marking envelope "University Appointment" (October 26).

LECTURER/SENIOR LECTURER IN APPLIED MATHEMATICS at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 29).

CHAIR OF EDUCATION in the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

LECTURER IN PHYSICAL METALLURGY at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, October 31).

LECTURER OR ASSISTANT LECTURER IN GEOLOGY at the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 31).

SENIOR LECTURER (with a degree in engineering and practical experience in applied hydraulic work) IN CIVIL ENGINEERING (Hydraulics) at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

SENIOR LECTURER (with a degree in veterinary medicine or an honours degree in science or agricultural science) IN ANIMAL HUSBANDRY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

UNIVERSITY DEMONSTRATOR IN BIOCHEMISTRY—Prof. H. A. Krebs, Department of Biochemistry, South Parks Road, Oxford (October 31).

BIOLOGIST (with a recognized university degree, with honours, or equivalent qualification, for which an adequate study of biology or zoology was necessary)—The Secretary, The Salmon Research Trust of Ireland Incorporated, St. James's Gate, Dublin (November 1).

NUCLEAR TECHNOLOGIST (with an honours degree in physics or engineering, and experience in nuclear engineering, reactor technology, and instrumentation) at the Central Electricity Authorities' Research Laboratories at Leatherhead, to deal with problems likely to arise in the operation of reactors in nuclear power stations—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. T./884 (November 12).

CHAIR OF PHYSICS in the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30).

BIOCHEMIST (with a first- or second-class honours degree in biochemistry or equivalent qualification, and postgraduate research experience) to study the chemical properties of cervical mucus in relation to the action of sex hormones—The Secretary, National Institute for Research in Dairying, Shinfield, Reading.

BIOCHEMIST (with a good honours degree in biochemistry) AT THE GOVERNMENT TEA RESEARCH STATION, Mlanje, to conduct research on the fermentation of tea—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/4/018.

BOTANIST (with at least a second-class honours degree in botany) to undertake taxonomic botanical work at Kew and the British Museum (Natural History) and possibly periods of field work in Africa, in connexion with the preparation of a Flora of Rhodesia—The Director of Recruitment, Colonial Office, London, S.W.1, quoting RES.134/1/02.

CHIEF RESEARCH CHEMIST (with a Ph.D. degree in biochemistry and some successful experience in an organized research programme) IN THE SASKATCHEWAN DEPARTMENT OF PUBLIC HEALTH, to supervise the biochemical aspects of psychiatric research in Saskatchewan—The Public Service Commission, Legislative Building, Regina, Saskatchewan, quoting Ref. No. 4356.

CHIEF TECHNICIAN OR SENIOR TECHNICIAN TO TAKE CHARGE OF HYDROGEN LIQUEFACTION PLANT—The Steward, Physics Department, The University, Edgbaston, Birmingham 15.

CYCLOTRON ENGINEER or PHYSICIST (graduate in light electrical engineering)—The Senior Cyclotron Engineer, Medical Research Council, Hammersmith Hospital, Ducane Road, London, W.12.

HEAD (graduate of a British university and good experience in teaching and in industry) OF THE DEPARTMENT OF ELECTRICAL ENGINEERING AND PHYSICS—Clerk to the Governing Body, Borough Polytechnic, Borough Road, London, S.E.1.

HEAD OF THE MICROBIOLOGY DEPARTMENT—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

LECTURER (science graduate, preferably in microbiology, and with experience in dairy technology)—The Principal, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

LECTURERS (with an engineering or science degree, preferably lecturing experience, and a specialist knowledge of either electrical engineering or electronics, or servo-mechanisms) AT THE R.E.M.E. TRAINING CENTRE, Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.387/6A.

PALÆONTOLOGIST (with a first- or good second-class honours degree in geology and at least six years postgraduate work in palæontology, and a fair knowledge of micropalæontology) with the Government of Cyprus Geological Survey, to identify fossils and microfauna in order to determine the age of sedimentary formations, and to assist in the mapping of fossiliferous formations—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/17/03.

RADIATION CHEMIST (with a Ph.D. or equivalent qualifications, and several years experience in the radiation chemistry of aqueous systems and solution reaction kinetics) in the Defence Research Chemical Laboratories, Ottawa, Canada—Defence Research Member, Canadian Joint Staff, Moncorvo House, 66 Ennismore Gardens, London, S.W.7.

RESEARCH ASSISTANT (graduate in biochemistry or chemistry) IN THE DEPARTMENT OF CLINICAL PATHOLOGY—The Administrator and Secretary, University College Hospital, Gower Street, London, W.C.1.

SENIOR RESEARCH ASSISTANT (with a good honours degree in metallurgy or physics, practical experience and/or research training) IN THE FACULTY OF APPLIED SCIENCE, to work in the field of creep and fatigue of ferrous materials—The Registrar, The University, Nottingham.

TECHNICAL OFFICER (with good practical experience, and preferably a degree or diploma in agriculture) FOR CEREAL MULTIPLICATION—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Food Manufacturing Industries Research Association. Ninth Annual Report and Accounts, 1955. Pp. 36. (Leatherhead: British Food Manufacturing Industries Research Association, 1956.) [177

National Institute of Agricultural Botany. Thirty-Sixth Report and Accounts, 1955. Pp. 54. (Cambridge: National Institute of Agricultural Botany, 1956.) [177

Department of Scientific and Industrial Research. Report of the Fuel Research Board with the Report of the Director of Fuel Research for the year 1955. Pp. vi+70+8 plates. (London: H.M. Stationery Office, 1956.) 4s. net. [177

Institute of Personnel Management. Occasional Papers. No. 10: Employment of Coloured Workers in the Birmingham Area. By Leslie Stephens. (Report of an enquiry initiated by the Birmingham Christian Social Council and undertaken by the Race Relations Group of Fircroft College, Birmingham.) Pp. 30. (London: Institute of Personnel Management, 1956.) 3s. 6d. [177

Publications of the Thoresby Society. Kirkstall Abbey Excavations—Sixth Report, 1955. Pp. 26+2 plates. (Leeds: The Thoresby Society, 1956.) 1s. [177

Industrial Diamond Information Bureau. Bibliography of Hardness and Hardness Testing from 1937 to 1955. Pp. iv+118. (London: Industrial Diamond Information Bureau, 1956.) 5s. 6d. [177

Press Authority Bill (H.L.) Pp. ii+3. (London: H.M. Stationery Office, 1956.) 6d. net. [177

Iodine Information. No. 46: Influenza and the Common Cold: Iodine Prophylaxis and Treatment. Pp. 16. No. 47: Iodized Minerals. Pp. 24. No. 48: Nutrition of Farm Animals. Pp. 14. (London: Chilean Iodine Educational Bureau, 1956.) [197

The Morgan Crucible Company Limited. Battersea Works 1856–1956. Pp. 67 (3 plates). (London: The Morgan Crucible Company Limited, 1956.) [197

Thirty-sixth Annual Report of the Board of the Institute of Physics, 1955. Pp. 18. (London: Institute of Physics, 1956.) [197

Ministry of Agriculture, Fisheries and Food. Bulletin No. 37: Silage. Seventh edition. Pp. iv+58+4 plates. (London: H.M. Stationery Office, 1956.) 3s. net. [197

London and Home Counties Regional Advisory Council for Higher Technological Education. Bulletin of Special Courses in Higher Technology, including Management Studies and Commerce, 1956–7. Part 1: Autumn Term 1956. Pp. 82. (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1956.) 1s. 6d. [197

Ministry of Housing and Local Government: Department of Health for Scotland. Alkali, etc. Works Regulation Act, 1906, and Alkali etc. Works Orders 1928–1950. Alkali etc. Works Regulation (Scotland) Acts, 1906 and 1951. Ninety-Second Annual Report on Alkali etc. Works by the Chief Inspectors, 1955. Pp. 51. (London: H.M. Stationery Office, 1956.) 2s. net. [257

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1954–1955. Pp. 50. (Cmd. 9800.) (London: H.M. Stationery Office, 1956.) 2s. 9d. net. [257

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1955. Pp. 224+12 plates. (Bristol: The University, 1956.) 15s. [257

Ministry of Fuel and Power. Dust Prevention and Suppression. Instructional Pamphlet No. 2: Dust Suppression with the Meco-Moore Cutter Loader and the Gloster Getter. By the East Midlands Divisional Committee on Dust Prevention and Suppression. Pp. ii+9. (London: H.M. Stationery Office, 1956.) 1s. 3d. net. [257

Other Countries

New Zealand Forest Service: Forest Research Institute. Research Notes. No. 5 (March 1956): Yield of Unthinned Douglas Fir, Corsican Pine, and Ponderosa Pine in New Zealand. By G. Duff. Pp. 40. (Wellington: Government Printer, 1956.) [197

United States Department of Commerce: National Bureau of Standards. Circular No. 571: Electron Physics Tables. By L. Marton, C. Marton and W. G. Hall. Pp. i+83. (Washington, D.C.: Government Printing Office, 1956.) 50 cents. [197

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 1287: Surface Water Supply of the United States, Part 13: Snake River Basin. Prepared under the direction of J. V. B. Wells. Pp. viii+255. 1 dollar. Bulletin 975-E: Geology and Ore Deposits of the Atacocha District, Departamento de Pasco, Peru. By Robert F. Johnson, Richard W. Lewis, Jr., and Guillermo Abeie C. Pp. iv+337–388+plates 23–30. 2 dollars. Bulletin 1021-E: Geology of Comb Ridge and Vicinity North of San Juan River, San Juan County, Utah. By Julian D. Sears. Pp. iv+167–208+plates 17–20. 75 cents. Bulletin 1026: Geology of the Bighorn Canyon-Hardin Area, Montana and Wyoming. By Paul W. Richards. Pp. v+94+7 plates. n.p. Bulletin 1027-I: Perlite Resources of the United States. By Marion C. Jaster. Pp. iii+379–404+plate 44. n.p. Professional Paper 273: Geology and Mineral Deposits of the Boleo Copper District, Baja California, Mexico. By Ivan F. Wilson. Pp. vi+134+11 plates. n.p. Professional Paper 282-A: Ephemeral Streams—Hydraulic Factors and Their Relation to the Drainage Net. By Luna B. Leopold and John P. Miller. Pp. iv+37. 45 cents. (Washington, D.C.: Government Printing Office, 1955 and 1956.) [197

Proceedings of the United States National Museum. Vol. 105, No. 3360: The Spongilla-Flies, with Special Reference to Those of the Western Hemisphere (Sisyridae, Neuroptera). By Sophy I. Parfin and Ashley B. Gurbey. Pp. 421–529+3 plates. Vol. 106, No. 3363: A Revision of the Flies of the Genus *Rivellia* (Otitidae, Diptera) of America North of Mexico. By Ryoji Namba. Pp. 21–84. (Washington, D.C.: Smithsonian Institution, United States National Museum, 1956.) [277

Metropolitan Life Insurance Company. Statistical Bulletin. Vol. 37 (June 1956): Cancer in Midlife. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [277

United States Department of the Interior: Geological Survey. Bulletin 1027-P: Geology of the Murray Area, Shoshone County, Idaho. By John W. Hosterman. Pp. iii+725–748. 1 dollar. Bulletin 1036-F: A Spectrographic Method for Determining the Hafnium-Zirconium Ratio in Zircon. By C. L. Waring and W. H. Worthing. Pp. iii+81–90. 15 cents. (Washington, D.C.: Government Printing Office, 1956.) [277

Bulletin of the Bingham Oceanographic Collection. Vol. 16, Article 1: The Annual Cycle of Phytoplankton in the Labrador Sea, 1950–51. By Robert William Holmes. Pp. 74. (New Haven, Conn.: Peabody Museum of Natural History, Yale University, 1956.) 1.50 dollars. [277

Carnegie Institution of Washington. Publication 552A: The Mutants of Drosophila Melanogaster Classified according to Body Parts Affected. By Norma B. Braver. Pp. v+36. (Washington, D.C.: Carnegie Institution of Washington, 1956.) 0·25 dollars. [277

Australian and New Zealand Association for the Advancement of Science. Report of the Thirtieth Meeting, Canberra, January, 1954. Edited by C. S. Daley. Pp. x+370. (Sydney: Australian and New Zealand Association for the Advancement of Science, 1955.) [277

Symposium on Structure of Enzymes and Proteins given at the Research Conference for Biology and Medicine of the Atomic Energy Commission, Gatlinburg, Tennessee, April 4–6, 1955. Sponsored by the Biology Division, Oak Ridge National Laboratory. (Reprinted from the *Journal of Cellular and Comparative Physiology*, Vol. 47, Supplement 1, May, 1956.) Pp. vii+294. (Philadelphia: Wistar Institute of Anatomy and Biology, 1956.) [277

Théodore Schwann et les Débuts de la Médecine Scientifique. Par Prof. M. Marcel Florkin. (Les Conférences du Palais de la Découverte, Série D, No. 43.) Pp. 22. (Paris: Université de Paris, 1956.) [277

Mitteilungen des Deutschen Wetterdienstes. No. 15 (Band 3): Berechnung monatlicher Mittelwerte der Gebietsverdunstung nach einer Merhode von Kalweit. Von Siegfried Uhlig. Pp. 30. (Bad Kissingen: Deutschen Wetterdienstes, 1956.) [277

Bulletin of the American Museum of Natural History. Vol. 110, Article 5: On the Original Varieties of Taxonomy and Their Regressions Upon Size in Fishes. By Albert E. Parr. Pp. 369–398. 50 cents. Vol. 110, Article 6: Triassic Metoposaurid Amphibians. By Edwin Harris Colbert and John Imbrie. Pp. 399–452+plates 25–28. 1 dollar. Vol. 111, No. 1: A Monograph of the Ithomiidae (Lepidoptera). By Richard M. Fox. Pp. 1–76+plates 1–9. 1.50 dollars. (New York: American Museum of Natural History, 1956.) [277

Report of the Thirty-first Meeting of the Australian and New Zealand Association for the Advancement of Science, Melbourne, August, 1955—Part 3. (*The Australian Journal of Science*, Vol. 18, No. 5A, May, 1956.) Pp. 125–204. (Sydney: Fairway Publications, Pty., Ltd., 1956. Published on behalf of the A.N.Z.A.A.S.) [277

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office.